DRINKING WATER SYSTEM MASTER PLAN

(HAL Project No.: 126.27.200)

FINAL

December 2013

HANSEN ALLEN & LUCE INC
ENGINEERS

CITY OF SOUTH SALT LAKE

DRINKING WATER SYSTEM MASTER PLAN

(HAL Project No.: 126.27.200)

PROFESSIONAL ENGINEER
11 Dec 2013
No. 362076-2202
STEVEN C.
JONES
STATE OF UTAH

Steven C. Jones, P.E.
Project Engineer

HANSEN
ALLEN
& LUCE INC
ENGINEERS

December 2013

TABLE OF CONTENTS

TABLE OF CONTENTS i
LIST OF TABLES iii
LIST OF FIGURES iii
ACKNOWLEDGMENTS iv
GLOSSARY OF TECHNICAL TERMS v
ABBREVIATIONS vi

CHAPTER I INTRODUCTION I-1
PURPOSE I-1
SCOPE I-1
BACKGROUND I-1
WATER SYSTEM MASTER PLANNING APPROACH I-2
KEY SYSTEM DESIGN CRITERIA AND PERFORMANCE FINDINGS I-2

CHAPTER II CONNECTIONS II-1
EXISTING CONNECTIONS II-1
CONNECTIONS PROJECTED AT BUILD-OUT II-2

CHAPTER III SOURCES III-1
EXISTING SOURCES III-1
EXISTING SOURCE REQUIREMENTS III-2
Existing Peak Day Demand III-2
Existing Average Yearly Demand III-3
BUILD-OUT SOURCE REQUIREMENTS III-4
Build-Out Peak Day Demand III-4
Build-Out Average Yearly Demand III-4
SOURCE REDUNDANCY III-5
SOURCE RECOMMENDATIONS III-5

CHAPTER IV WATER STORAGE AND BOOSTER PUMPS IV-1
EXISTING STORAGE IV-1
EXISTING STORAGE REQUIREMENTS IV-1
Equalization Storage IV-1
Fire Suppression Storage IV-2
Emergency Storage IV-3
BUILD-OUT STORAGE REQUIREMENTS IV-3
EXISTING BOOSTER PUMPS IV-3
BOOSTER PUMP AND STORAGE RECOMMENDATIONS IV-5

CHAPTER V DISTRIBUTION SYSTEM V-1
EXISTING DISTRIBUTION SYSTEM V-1
EXISTING DISTRIBUTION SYSTEM REQUIREMENTS V-1
Existing Peak Instantaneous Demand V-1
Existing Peak Day Plus Fire Flow Demand V-2
BUILD-OUT DISTRIBUTION SYSTEM REQUIREMENTS V-2
Build-Out Peak Instantaneous Demand V-2
Build-Out Peak Day Demand Plus Fire Flow V-2
COMPUTER MODEL V-2
MODEL COMPONENTS V-3
Pipe Network V-3

Demands V-3
Sources, Storage Tanks, and Booster Stations V-3
MODEL CALIBRATION V-3
ANALYSIS METHODOLOGY V-4
High Pressure Conditions V-4
Peak Instantaneous Demand Conditions V-4
Peak Day Demand Plus Fire Flow Conditions V-5
Peak Day Extended Period V-6
MODEL OUTPUT V-6
CONTINUED USE OF THE COMPUTER PROGRAM V-6
DISTRIBUTION SYSTEM RECOMMENDATIONS V-7

CHAPTER VI WATER QUALITY VI-1
WATER AGE AND DISINFECTION BYPRODUCT EVALUATION VI-1
CHLORINE RESIDUAL EVALUATION VI-1
SUMMARY OF WATER QUALITY RECOMMENDATIONS VI-5

CHAPTER VII CAPITAL IMPROVEMENTS PLAN VII-1
PRECISION OF COST ESTIMATES VII-1
SYSTEM IMPROVEMENT PROJECTS VII-2
FUNDING OPTIONS VII-4
General Obligation Bonds VII-4
Revenue Bonds VII-4
State/Federal Grants and Loans VII-4
Impact Fees VII-5
SUMMARY OF RECOMMENDATIONS VII-5
REFERENCES R-1

APPENDIX A – ERC Calculations
APPENDIX B – Water Rights
APPENDIX C – Calibration Data
APPENDIX D – Computer Model Output
APPENDIX E – Water Quality Calibration Data
APPENDIX F – Cost Estimate Calculations
APPENDIX G – DDW Report Certification

LIST OF TABLES

NO.	TITLE	PAGE
I-1	Key System Design Criteria	I-3
I-2	Design Flow Summary	I-3
II-1	Existing ERCs	II-1
II-2	Build-out ERCs	II-2
III-1	Summary of South Salt Lake Wells	III-1
III-2	Summary of JVWCD Connections	III-1
III-3	Existing Source Requirements	III-3
III-4	Build-Out Source Requirements	III-4
III-5	Build-Out Average Yearly Requirements	III-5
IV-1	Existing Storage Tanks	IV-1
IV-2	Existing Water Storage Requirements	IV-2
IV-3	Build-Out Storage Requirements	IV-3
IV-4	Booster Pump Characteristics	IV-4
IV-5	Storage and Booster Recommendations	IV-4
V-1	Proposed General Improvement Projects	V-7
V-2	Proposed Zone 2 Fire Flow Projects	V-8
VI-1	Dosing Concentrations Assumed at Sources	VI-3
VII-1	Project Costs for System Improvements	VII-2

LIST OF FIGURES

NO.	TITLE	PAGE
I-1	Existing Drinking Water System Map	After I-2
II-1	TOD Areas	After II-2
III-1	Peak Day Diurnal Curve for South Salt Lake City	III-2
V-1	Summary of Pipe Length by Diameter	V-1
VI-1	Water Age Modeling Results	VI-2
VI-2	Chlorine Residual Modeling Results	VI-4
VI-3	Field Test vs. Modeled Chlorine	VI-5
VII-1	Recommended Improvement Projects	After VII-3

ACKNOWLEDGMENTS

Successful completion of this study was made possible by the cooperation and assistance of many individuals, including the Mayor of South Salt Lake, City Council Members, and City Staff personnel as shown below. We sincerely appreciate the cooperation and assistance provided by these individuals.

City of South Salt Lake

Mayor

Cherie Wood

City Council

Casey R. Fitts
Mike Rutter
Ryan Gold
Boyd Marshall
John B. Weaver
Roy Turner
Irvin Jones

City Staff

Dennis Pay, Public Works Director
Ed Rufener, Deputy Director
Marvin Taylor, Water Division Supervisor
Jason Taylor, Field Supervisor

GLOSSARY OF TECHNICAL TERMS

Average Daily Flow: The average yearly demand volume expressed in a flow rate.

Average Yearly Demand: The volume of water used during an entire year.

Build-out: When the development density reaches maximum allowed by planned development.

Demand: Required water flow rate or volume.

Distribution System: The network of pipes, valves and appurtenances contained within a water system.

Drinking Water: Water of sufficient quality for human consumption. Also referred to as Culinary or Potable water.

Dynamic Pressure: The pressure exerted by water within the pipelines and other water system appurtenances when water is flowing through the system.

Equivalent Residential Connection: A measure used in comparing water demand from non-residential connections to residential connections.

Fire Flow Requirements: The rate of water delivery required to extinguish a particular fire. Usually it is given in rate of flow (gallons per minute) for a specific period of time (hours).

Head: A measure of the pressure in a distribution system that is exerted by the water. Head represents the height of the free water surface (or pressure reduction valve setting) above any point in the hydraulic system.

Headloss: The amount of pressure lost in a distribution system under dynamic conditions due to the wall roughness and other physical characteristics of pipes in the system.

Peak Day: The day(s) of the year in which a maximum amount of water is used in a 24-hour period.

Peak Day Demand: The average daily flow required to meet the needs imposed on a water system during the peak day(s) of the year.

Peak Instantaneous Demand: The flow required to meet the needs imposed on a water system during maximum flow on a peak day.

Pressure Reducing Valve (PRV): A valve used to reduce excessive pressure in a water distribution system.

Pressure Zone: The area within a distribution system in which water pressure is maintained within specified limits.

Service Area: Typically the area within the boundaries of the entity or entities that participate in the ownership, planning, design, construction, operation and maintenance of a water system.

Static Pressure: The pressure exerted by water within the pipelines and other water system appurtenances when water is not flowing through the system, i.e., during periods of little or no water use.

Storage Reservoir: A facility used to store, contain and protect drinking water until it is needed by the customers of a water system. Also referred to as a Storage Tank.

Transmission Pipeline: A pipeline that transfers water from a source to a reservoir or from a reservoir to a distribution system.

Water Conservation: Planned management of water to prevent waste.

ABBREVIATIONS

ac-ft	acre-feet
DDW	The State of Utah Division of Drinking Water
ERC	Equivalent Residential Connection
GIS	Geographic Information System
gpd	Gallons per Day
gpd/conn	Gallons per Day per Connection
gpm	Gallons per Minute
HAL	Hansen, Allen & Luce, Inc.
JVWCD	Jordan Valley Water Conservancy District
MG	Million Gallons
PRV	Pressure Reducing Valve
psi	Pounds per Square Inch
SCADA	Supervisory Control And Data Acquisition

CHAPTER I

INTRODUCTION

PURPOSE

The purpose of this master plan is to provide specific direction to the City of South Salt Lake for decisions that will be made over the next 5 to 40 years in order to help the City provide adequate water to customers at the most reasonable cost. Recommendations are based on City drinking water demand data and standards established by the Utah Division of Drinking Water (DDW).

SCOPE

The scope of this master plan includes a study of the City's drinking water system and customer water use including: build-out growth projections, source requirements, water rights, storage requirements, distribution system requirements and water quality. From this study of the water system, an implementation plan with recommended improvements has been prepared. The implementation plan includes conceptual-level cost estimates for the recommended improvements.

The conclusions and recommendations of this study are limited by the accuracy of the development projections and other assumptions used in preparing the study. It is expected that the City will review and update this master plan every 5-10 years or more frequently if indicated by a significant change in development.

BACKGROUND

The City of South Salt Lake was incorporated in 1938. The desire for water and sewer services was one of the primary motivations in the effort to incorporate the City. South Salt Lake experienced rapid growth following incorporation, and shortly after World War II, the population had reached 10,000. After the initial rapid increase in population, residential growth slowed, while considerable commercial and industrial development continued. In 1998, South Salt Lake annexed areas to the south of the City between 3300 South and 3900 South. Two years after the annexation, the 2000 Census was completed. At that time the City had a population of just over 22,000. Modest growth continued through the following decade and in 2010 the most recent census gave a population of just over 23,600. Over time, South Salt Lake has developed into a diverse mix of single- and multi-family residences, commercial and business areas, and a variety of light industries.

An aging water distribution system and wells with declining flow capacity are two major issues that South Salt Lake City must address in order to meet future water system demands. Much of the existing water distribution system was constructed in 1948. Many of the original unlined cast iron pipes have now been in the ground for over 50 years and are nearing the end of their useful life. Culinary water for South Salt Lake is currently supplied from two general source categories. The City owns and operates its own wells and the City purchases wholesale water from Jordan Valley Water Conservancy District (JVWCD). Growing water demand and no excess capacity in the City wells have forced the City to an increasing dependence on water supplied from JVWCD, which is significantly more expensive than water obtained from the City's wells. In addition to the two primary sources, South Salt Lake also maintains two connections with the Salt Lake City distribution network. However, usage of the Salt Lake connections is generally avoided as the cost is much higher than the JVWCD water.

Figure I-1 illustrates the extent of the South Salt Lake water system. To the east of State Street the land usage is primarily residential. Between State Street and I-15 there is a mix of land usage with commercial, residential, light industrial and mixed use zones. West of I-15, the land usage is primarily light industrial. As shown, the distribution network is divided into western and eastern pressure zones. The eastern zone has been labeled as Zone 1, and is composed of a mixture of various land uses. The western zone, Zone 2, is composed primarily of light industrial areas. Although Zone 1 and Zone 2 have similar elevations, the pressure in Zone 2 is maintained 25 to 30 psi higher than the pressure in Zone 1. Combining the two zones into a single zone has been considered; however, many of the buildings in Zone 2 include fire suppression sprinkler systems which were designed based on the higher Zone 2 pressures. For this reason, the separation between the pressure zones has been maintained.

WATER SYSTEM MASTER PLANNING APPROACH

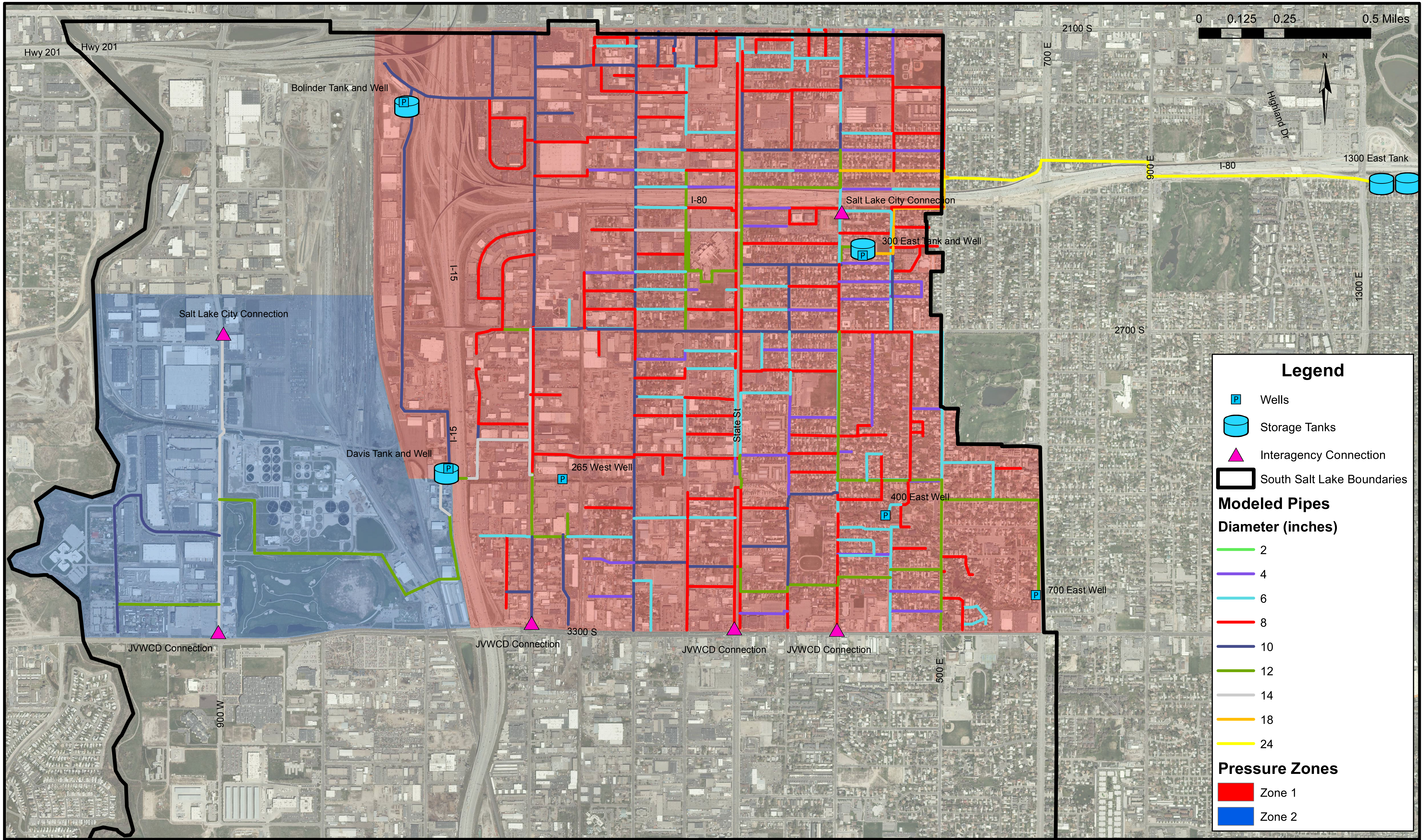
The South Salt Lake water distribution network is made up of a variety of components including booster pumps, storage facilities, valves, and pipes. The City water system must be capable of responding to daily and seasonal variations in demand while concurrently providing adequate capacity for firefighting and other emergency needs. In order to meet these goals, each of the distribution system components must be designed and operated properly. Furthermore, careful planning is required in order to ensure that the distribution system is capable of meeting the City's needs over the next several decades.

Both present and future needs were evaluated in this master plan. Present water needs were calculated according to Utah Division of Drinking Water (DDW) requirements and compared with actual water use records obtained from billing record data and system flow records. Future water needs were estimated by identifying locations where redevelopment is expected, adding the incremental increase in water demand associated with the development to the current demand. South Salt Lake’s build-out water demand was estimated by applying this process throughout City.

In order to facilitate the analysis of South Salt Lake’s drinking water system, a computer model of the system was prepared and analyzed in two parts. First, the performance of existing facilities with present water demands was analyzed. Next, projected future demands were added to the drinking water system and the analysis was repeated. Recommendations for system improvements were prepared based on the results of this analysis. This report is organized to follow the outline of the DDW requirements found in section R309-510 of the Utah Administrative Code entitled “Minimum Sizing Requirements”.

KEY SYSTEM DESIGN CRITERIA AND PERFORMANCE FINDINGS

Summaries of the key water system design criteria and performance findings for the South Salt Lake drinking water system are included in Table I-1. The design criteria were used in evaluating system performance and in recommending future water system improvements. Table I-2 presents the design flows analyzed in the drinking water model.



HANSEN ALLEN & LUCE inc
ENGINEERS

SOUTH SALT LAKE CITY
DRINKING WATER SYSTEM MASTER PLAN

EXISTING SYSTEM

FIGURE
I-1

TABLE I-1
KEY SYSTEM DESIGN CRITERIA

	CRITERIA	2013 EXISTING REQUIREMENTS	ESTIMATED BUILD-OUT REQUIREMENTS
EQUIVALENT RESIDENTIAL CONNECTIONS	Calculated	6,337 ERCs	12,677 ERCs
SOURCE			
Peak Day Demand	R309-510	5,779 gpm	9,301 gpm
Average Yearly Demand	R309-510	4,550 ac-ft	7,391 ac-ft
STORAGE			
Equalization	R309-510	4.16 MG	6.70 MG
Fire Suppression	Highest fire flow volumes	1.50 MG	1.50 MG
Emergency	20% of Fire and Eq.	1.13 MG	1.64 MG
Total		6.79 MG	9.84 MG
DISTRIBUTION			
Peak Instantaneous	1.6 x Peak Day Demand	9,246 gpm	14,882 gpm
Minimum Fire Flow	@ 20 psi	1,200 gpm	1,200 gpm
Max Operating Pressure	City Preference	110 psi	110 psi
Min. Operating Pressure	City Preference	50 psi	50 psi

TABLE I-2
DESIGN FLOW SUMMARY

SCENARIO		CALCULATION PROCEDURE	DEMAND	FLOW RATIO
Average Day	Existing	0.445 gpm/ERC	2,821 gpm	ADD/ADD = 1.00
	Build-Out	Existing demand Indoor demand for new future ERCs	2,821 gpm 1,761 gpm 4,582 gpm	ADD/ADD = 1.00
Peak Day	Existing	0.912 gpm/ERC	5,779 gpm	PDD/ADD = 2.05
	Build-Out	Existing demand Indoor demand for new future ERCs	5,779 gpm 3,522 gpm 9,301 gpm	PDD/ADD = 2.03
Peak Instantaneous	Existing	1.459 gpm/ERC	9,246 gpm	PID/ADD = 3.28
	Build-Out	Existing demand Indoor demand for new future ERCs	9,246 gpm 5,636 gpm 14,882 gpm	PID/ADD = 3.25

CHAPTER II

CONNECTIONS

EXISTING CONNECTIONS

According to 2012 connection information reported to the Division of Water Resources, the South Salt Lake distribution network includes 3,314 connections. Of this total, 2,371 are residential connections and 943 connections are nonresidential. An Equivalent Residential Connection (ERC) is a measure used in comparing water demand from non-residential connections to residential connections. By definition, each typical residential connection represents 1 ERC. The demand per ERC was evaluated based on Utah Administrative Code R309-510-7. As defined by Utah code, the peak day indoor demand per ERC is 800 gallons/day (0.56 gpm/ERC).

Outdoor demand per ERC is dependent upon the irrigated acreage associated with each ERC. Irrigated acreage was estimated by randomly selecting ten residential properties and measuring the irrigated acreage attached to each property. Based on these measurements, an average irrigated acreage of 0.09 acres was associated with each ERC. Multiplying 0.09 acres/ERC by the total number ERCs gives a total irrigated acreage of 570 acres. South Salt Lake is located in consumptive use zone 4 (refer to R309-510-7(3)), giving a peak day outdoor demand of 0.36 gpm/ERC.

Summing the indoor and outdoor demands gives a total peak day demand of 1313 gallons/day (0.91 gpm) per ERC. In order to express the commercial and industrial demands in terms of ERCs, the average demand for those connections was divided by the demand per ERC. Additional ERCs were also added to account for the irrigation of the open spaces located throughout the City. In all, the total number of ERCs computed for South Salt Lake was 6,337. Of the total, 2,605 represent residential demands, 2,837 represent commercial and industrial demands, and 895 represent the irrigation of open spaces (see Appendix A for ERC calculations). Table II-1 is a summary of ERCs by pressure zone.

TABLE II-1
EXISTING ERCS

PRESSURE ZONE	ERCs
1	5,542
2	795
TOTAL	**6,337**

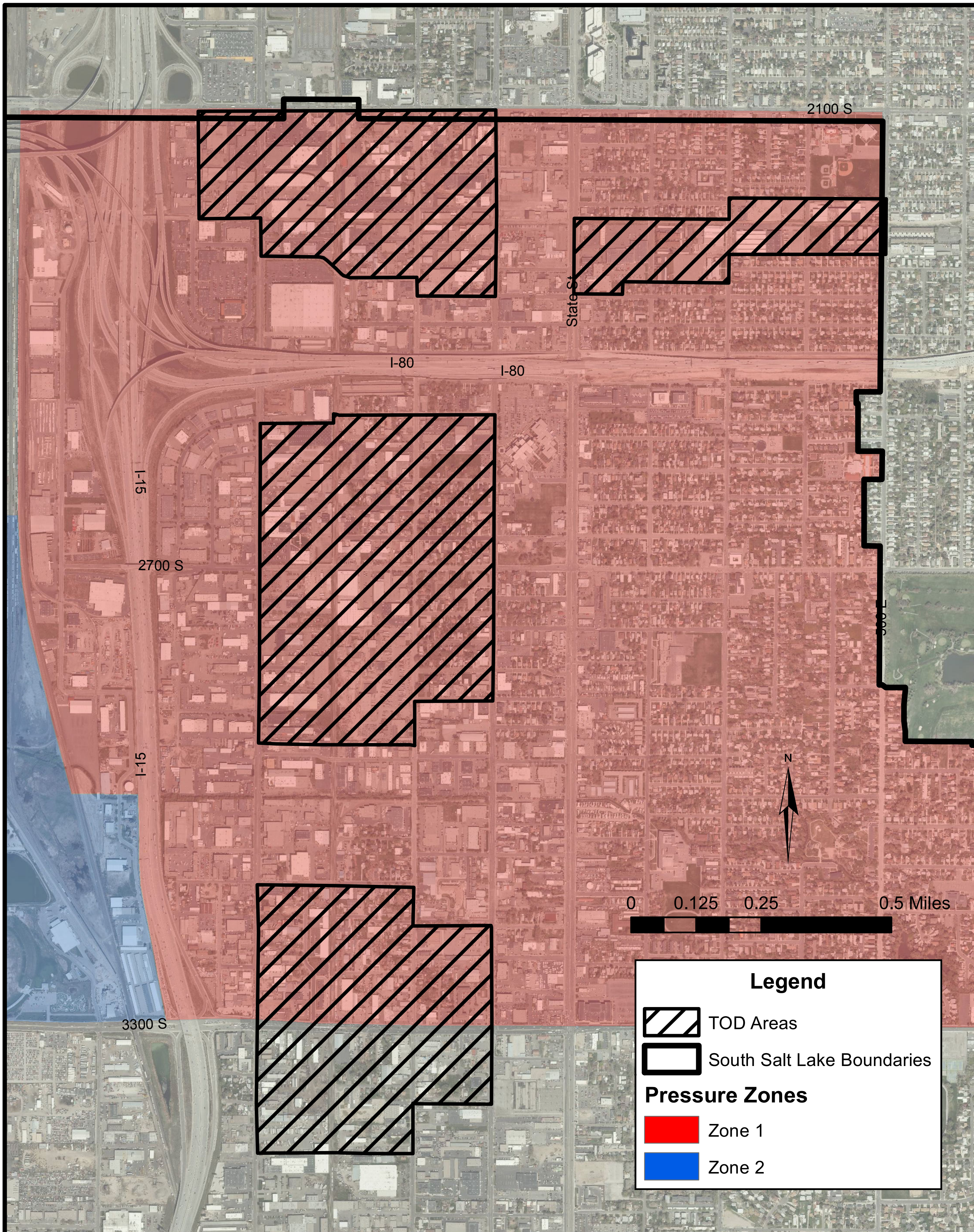
Existing system design flows were calculated based on the calculated ERCs and R309-510. Demand within the system was distributed using billing data. The billing data included the billed water used as well as the address describing the location of use. The addresses were used to geocode the locations of each billing account. By assigning the demands associated with the billing account to the nearest nodes within the South Salt Lake drinking water system, demands were distributed in a realistic manner based on actual usage. Because the geocoded demands were obtained from monthly data, it was then necessary to scale the individual nodal demands so that the sum of the individual demands equaled the design flow.

CONNECTIONS PROJECTED AT BUILD-OUT

South Salt Lake City is close to build-out. As a result, increases in demand are primarily expected to be the result of redevelopment. By extension, indoor demand is expected to increase over time as new connections are added, while outdoor demand is expected to remain mostly unchanged. Using the population projections from the 2010 census and the Governor's Office of Planning & Budget, the population of the city is expected to increase by about 100% by 2050. South Salt Lake has designated overlays for the purpose of directing redevelopment within specific areas. In particular, four transit oriented development (TOD) overlays exist within the service area of the South Salt Lake drinking water distribution network (see Figure II-1). Based on a review of building requirements within the TOD overlay areas, 25 ERCs/acre was selected as the total build-out ERC density for three of the overlay areas and the density of the fourth was raised to 9.65 ERCs/Arcre. It was assumed that all of the future growth will occur within the overlay areas. By 2050, 6,340 ERCs are expected to be added to the TOD areas. Table II-2 provides a summary of the build-out ERCs by pressure zone.

TABLE II-2
BUILD-OUT ERCS

ZONE	ERC
1	11,882
2	795
TOTAL	**12,677**



HANSEN ALLEN & LUCE inc ENGINEERS	SOUTH SALT LAKE CITY DRINKING WATER SYSTEM MASTER PLAN	TOD Areas	FIGURE II-1

CHAPTER III

SOURCES

EXISTING SOURCES

The following paragraphs outline the water rights owned by South Salt Lake along with the corresponding sources. A summary of South Salt Lake water rights tied to existing wells is shown in Table III-1.

TABLE III-1
SUMMARY OF SOUTH SALT LAKE WELLS

SOURCE	PHYSICAL CAPACITY (gpm)	TOTAL OF ASSOCIATED WATER RIGHTS[1] (gpm)
300 East Well	725	920
265 West Well[2]	850	898
400 East Well[2]	500	707
700 East Well	1,000	1,795
Bolinder Well[2]	2,000	2,244
Davis Well	2,900	2,944

1. For an itemized list of the individual water rights see Appendix B
2. Currently not in use

The water rights included in Table III-1 sum to 9,508 gpm. However, the 265 West and Bolinder Wells have been abandoned, and the 400 East Well is currently inactive, leaving 5,659 gpm of useable water rights. The water rights associated with the unused and abandoned wells are unusable without transferring the rights to other potential sources. In addition, the City owns water rights that are not connected to existing or previous municipal water sources. These additional rights total to 2,103 gpm. All of the City's wells are located in Zone 1. A complete listing of the water rights owned by South Salt Lake has been included in Appendix B.

Besides the City owned wells, South Salt Lake also maintains four connections with Jordan Valley Water Conservancy District (JVWCD) as listed in Table III-2.

TABLE III-2
SUMMARY OF JVWCD CONNECTIONS

<table>
<tr><th>ZONE</th><th>SOURCE</th><th>METER SIZE (inches)</th><th>FLOW CAPACITY (gpm)</th><th>ANNUAL CONTRACT (acre-feet)</th></tr>
<tr><td>1</td><td>300 East JVWCD</td><td>6</td><td>700</td><td rowspan="4">1,020</td></tr>
<tr><td>1</td><td>State St JVWCD</td><td>6</td><td>700</td></tr>
<tr><td>1</td><td>300 West JVWCD</td><td>8</td><td>1,300</td></tr>
<tr><td>2</td><td>900 West JVWCD</td><td>10</td><td>1,500</td></tr>
<tr><td></td><td>TOTAL</td><td>-</td><td>4,200</td><td>1,020</td></tr>
</table>

All of the JVWCD connections are located along 3300 South. The connections are used to supplement the water obtained from the City's wells. South Salt Lake's current contract with JVWCD limits annual withdrawals from these connections to 1,020 acre-feet. As shown in Table III-2, the 900 West connection provides water to Zone 2, while the remaining connections provide water to Zone 1. The South Salt Lake network also shares two connections with the Salt Lake City network. One of the Salt Lake City connections is connected to Zone 1 and is located at 300 East Robert Avenue. The second is located at 2775 South 900 West and is connected to Zone 2. The Salt Lake City connections are only utilized during emergency situations.

EXISTING SOURCE REQUIREMENTS

DDW standards require that distribution network water sources must be able to meet the expected water demand for two conditions: peak day demand and average yearly demand. Each of these criteria will be addressed in the following paragraphs.

Existing Peak Day Demand

Peak day demand is the water demand on the day of the year with the highest water use and is used to determine the required source capacity under existing and build-out conditions. The two primary descriptors in characterizing peak day demand are the diurnal demand curve and average peak day demand. The peak day diurnal curve, in non-dimensional form, is shown Figure III-1.

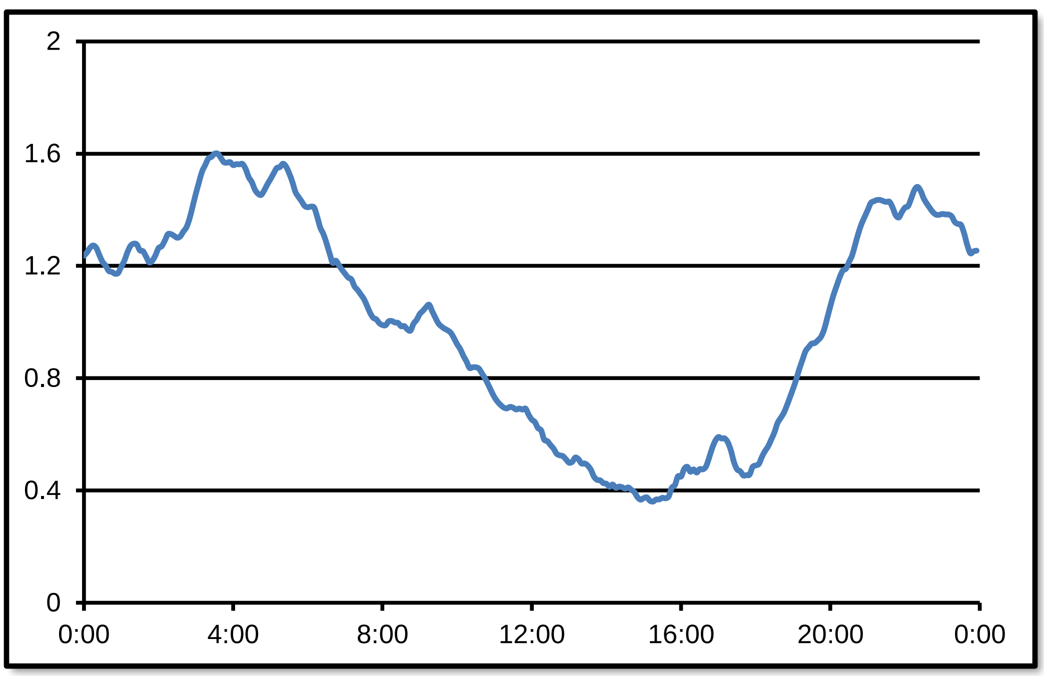


FIGURE III-2: PEAK DAY DIURNAL CURVE FOR SOUTH SALT LAKE CITY

The diurnal curve was obtained by analyzing South Salt Lake's production data. The non-dimensional form was obtained by dividing the instantaneous flow values by the daily average flow. The peak day average demand was found to be 0.912 gpm/ERC, corresponding to an average yearly flow of 0.556 gpm/ERC and a peak instantaneous flow of 1.459 gpm/ERC.

The primary peak occurs in the morning at about 3:45 AM, with a prolonged peak lasting until about 5:45 AM. The period with the lowest demand is during midafternoon at about 3:00 PM. The relatively high nighttime demand is likely a result of night time irrigation using automatic sprinklers.

Existing source requirements and capacities for each pressure zone are summarized in Table III-3. The “ERCs” and “Zone Demand (gpm/ERC)” columns are, respectively, the number of ERCs in each pressure zone and the average demand per ERC, both as outlined previously. The “Zone Demand (gpm)” column is the average demand estimated for each zone on the peak day.

TABLE III-3
EXISTING SOURCE REQUIREMENTS

ZONE	EXISTING SOURCE (PEAK DAY) DEMAND			EXISTING SOURCE CAPACITY (gpm)		CAPACITY REMAINING (gpm)	
	ERCs	DEMAND[1] (gpm/ERC)	DEMAND (gpm)	PHYSICAL	AVAILABLE[2]	PHYSICAL	AVAILABLE
1	5,542	0.912	5,054	7,325	8,359	2,271	3,305
2	795	0.912	725	1,500	1,450	725	725
TOTAL	6,337	NA	5,779	8,825	9,809	NA	NA

1. The demands are based on State Standards
2. Total of water rights tied to wells and contracted JVWCD water

Approximately **5,779** gpm is required to meet the existing demands of South Salt Lake City, with 5,054 gpm, and 725 gpm required for the individual pressure zones 1 and 2.

The “Existing Source Capacity” has been divided into “Physical” and “Available” categories. “Physical” capacity is the sum of the maximum physical capacities of each source (all wells and JVWCD connections) within the respective zone. Available capacity was determined through summation of the instantaneous water rights and the contracted JVWCD connection flow rates. “Capacity Remaining” is defined as the “Zone Demand” subtracted from the “Existing Source Capacity” and is divided into “physical” and “available” categories. For Zone 1, the remaining available source capacity is 3,305 gpm. However, due to the currently unavailable sources with associated water rights, the remaining physical capacity for Zone 1 is 2,271 gpm.

In addition to the sources listed above, water can also be pumped from Zone 1 into Zone 2 via the West Davis Booster Station; however, the City operates the West Davis Booster Pump as a redundant source for the JVWCD connection located at 900 West. As such, during general usage the City does not use the booster pump; rather, all of the water in Zone 2 is supplied by the JVWCD connection. For this reason the capacity associated with the West Davis Booster Station has not been included in Table III-3.

Existing Average Yearly Demand

Water utilities must also be able to supply the average yearly demand. Average yearly demand is the average volume of water used during the course of one year. Using State Standards, the average yearly demand for the South Salt Lake City distribution system was found to be **4,550** ac-ft. Summation of the water rights of available sources for the City gives 9,129 ac-ft, and the annual contract with JVWCD limits the connection volume to 1,020 ac-ft. The combination of available water rights and JVWCD connection (10,149 ac-ft) exceeds the average year demand. Therefore, on an annual basis 4,458 ac-ft of annual source capacity remains.

BUILD-OUT SOURCE REQUIREMENTS

Water demand is expected to increase as redevelopment occurs within the city. The following build-out source projections assume that the outdoor demand per ERC will not change between the existing and build-out scenarios. Accordingly, indoor use is expected to be the primary source of increased demand while outdoor use is expected to stay the same or perhaps decrease. South Salt Lake is mostly built-out and in order for additional development to occur open spaces will be reduced or existing development will be redeveloped to higher densities. As with existing water source requirements, future water source needs were evaluated on the basis of peak day demand and average yearly demand. Each requirement is addressed separately in the following paragraphs.

Build-Out Peak Day Demand

Table III-4 provides a summary of the build-out source requirements for South Salt Lake City with each column heading as previously defined for Table III-3. The projected total peak day demand at build-out is **9,301 gpm**. Zone 1 is projected to have deficits of 1,401 gpm in physical capacity and 217 gpm in available source capacity. Table III-4 illustrates that the City will need to obtain water sources capable of providing about 1,400 gpm to Zone 1. Water conservation efforts represent one alternative for reducing the projected shortfall. Two additional options for addressing this deficiency are making improvements in order to return unused and abandoned wells back into service and increasing the capacity of the City's JVWCD connections.

TABLE III-4
BUILD-OUT SOURCE REQUIREMENTS

ZONE	BUILD-OUT SOURCE (PEAK DAY) DEMAND			EXISTING SOURCE CAPACITY (gpm)		CAPACITY REMAINING (gpm)	
	ERCs	DEMAND[1] (gpm/ERC)	DEMAND (gpm)	PHYSICAL	AVAILABLE	PHYSICAL	AVAILABLE
1	5,542 (Ex.) 6,340 (Fut.) 11,882	0.912 0.556	5,054 3,522 8,576	7,175	8,359	-1,401	-217
2	795	0.912	725	1,450	1,450	725	725
TOTAL	12,677	NA	9,301	8,625	9,809	NA	NA

1. The demands are based on State Standards

Build-Out Average Yearly Demand

The projected average yearly demand at build-out is **7,391 ac-ft**. Of the total demand, 7,079 ac-ft is projected to be required for Zone 1 and 714 ac-ft for Zone 2, showing that all of the projected growth is expected to occur in Zone 1. The build-out annual demand is expected to be met by the annual available amount of water rights and contractual volume through the JVWCD connections. The physical capabilities of the sources are less than the water rights for the sources but still total to 8,238 ac-ft which will meet the build-out annual demand.

TABLE III-5
BUILD-OUT AVERAGE YEARLY REQUIREMENTS

ZONE	BUILD-OUT ANNUAL DEMAND (ac-ft)	BUILD-OUT ANNUAL CAPACITY	
		AVAILABLE (ac-ft)	REMAINING (ac-ft)
1	6,820	9,129[1]	2,309
2	571	1,020[2]	449
TOTAL	7,391	10,149	N/A

1. Available Water Rights for South Salt Lake City
2. Contractual annual volume for the JVWCD connection

SOURCE REDUNDANCY

It is recommended that the drinking water system have sufficient source capacity in order to meet all of the demand objectives with a major source unavailable. It is advisable to have sufficient capacity so there is no single source which is indispensable. For that reason it is recommended that redundancy be evaluated assuming the largest source will be unavailable. The largest South Salt Lake source is Davis Well, with a capacity of 2900 gpm. Under existing conditions, the City has a surplus physical capacity of 2,271 gpm; however, if Davis Well were to be unavailable, the City would face a deficit of 629 gpm.

Under the build-out scenario, there is insufficient capacity even with all of the current sources at full capacity. In order to meet build-out demands with full source redundancy South Salt Lake will need to be able to meet the projected deficit of 1,401 gpm without using Davis Well. Therefore the effective build-out deficit, considering redundancy, is 4,301 gpm.

SOURCE RECOMMENDATIONS

Under existing conditions, South Salt Lake has a deficit of 629 gpm when source redundancy is considered. When build-out demands are considered the deficit, including redundancy, swells to 4,301 gpm. As obtaining new water rights is generally difficult, it is recommended that South Salt Lake City meet the projected water demands through a combination of transferal of existing water rights and increasing their JVWCD contract volume. South Salt Lake City owns several water rights associated with sources that are not currently in service, such as the 300 West Well, 400 East Well, the Scott Hatchery Wells, and the Bolinder Well. It is recommended that existing water rights be transferred to viable sources, or that the necessary actions be taken so that sources currently out of service may be reintroduced to the drinking water system.

Specifically, it is recommended that a new well be drilled near the abandoned Bolinder Well. Bolinder Well was abandoned due to a collapse within the formation. Prior to abandonment, Bolinder Well provided good production with a nominal capacity of about 2,000 gpm. Furthermore, drilling a new well near the existing well will allow the City to use the Bolinder water rights, and Bolinder Tank. A new well at this location could supply sufficient water to provide redundancy under existing conditions.

Under build-out conditions additional sources will be needed. Assuming a replacement for Bolinder Well will produce about 2,000 gpm, another 2,300 gpm of capacity will still be required. It is recommended that the remaining flow capacity be reached through the construction of one new well and increasing the capacity from JVWCD to make up the difference. Because of the limited availability of undeveloped property in South Salt Lake, it is expected that property acquisition will be the limiting factor in new well construction. For this reason, it is suggested that the City assemble a list of suitable locations and prioritize the locations based on suitability. Items that should be considered include: proximity to transmission pipeline, impacts on water quality, property costs, issues associated with transferal of water rights, etc. One possible location for the well would be near the inactive 400 East Well.

In order to increase capacity from JVWCD, two options are suggested. The first option would be to add a new connection at 3300 S West Temple into the existing 10" line. A second option is to upsize the existing 300 East connection. The 300 East connection currently feeds into an 8-inch pipeline. However, there is a 12-inch transmission line just to the north at 3185 South and upsizing the pipe between the connection and the existing transmission line should increase the capacity of the connection. Prior to constructing any improvements for the purpose of increasing the City's capacity from JVWCD, the JVWCD system should be modeled and field testing conducted to ensure the JVWCD system has sufficient capacity to convey the desired flow. Within the "Capital Cost" section of this master plan it was assumed the first option, adding a new connection at 3300 S West Temple, would be selected.

CHAPTER IV

WATER STORAGE AND BOOSTER PUMPS

EXISTING STORAGE

The City's current drinking water system includes four storage facilities with a total capacity of 8 MG. The locations of storage facilities are shown on Figure I-1. The 1300 East tank is directly connected to Zone 1 and provides water to that zone via gravity flow. Bolinder Tank and 300 East tank are connected to Zone 1 via booster pump stations. Davis Tank is connected to both Zones 1 and 2 by booster pump stations. Table IV-1 presents a listing of the names and select attributes of the South Salt Lake water storage tanks.

TABLE IV-1
EXISTING STORAGE TANKS

FACILITY	TYPE	DIAMETER (ft)	VOLUME (MG)	TANK LEVELS			
				OUTLET	EMERG. STORAGE	FIRE SUPP.	OVERFLOW/ EQU.
300 East Tank	Concrete	110	1.0	4262.0 (0 feet)	N/A	N/A	4277.0 (15.0 feet)
1300 East Tank	Concrete	N/A	4.0	4402.0 (0 feet)	4409.9 (7.9)	4416.5 (14.5 feet)	4424.5 (22.5 feet)
Bolinder Tank	Steel	50	1.0	4236.0 (0 feet)	N/A	N/A	4272.0 (36.0 feet)
Davis Tank	Steel	95	2.0	4242.0 (0 feet)	N/A	N/A	4277.0 (35.0 feet)

Although Bolinder Tank is in serviceable condition, it is not currently operational. Previously, water from Bolinder Well was pumped into Bolinder Tank before being pumped out to Zone 1 via the Bolinder Booster Station. Bolinder Well is out of service due to irreparable damage. For this reason, the storage associated with Bolinder Tank has not been included in later tables within this section.

EXISTING STORAGE REQUIREMENTS

According to DDW standards, storage tanks must be able to provide: 1) equalization storage volume to make up the difference between the peak day flow rate and the peak instantaneous demand; 2) fire suppression storage volume to supply water for firefighting; and 3) emergency storage, if deemed necessary. A summary of the existing storage requirements for the drinking water system is provided in Table IV-2. Detailed explanations for each requirement have been included in the following paragraphs.

Equalization Storage

The need for equalization storage is highest during the irrigation season on days of peak water use. Equalization storage is used to meet peak demands during the time when demand exceeds the capacity of the sources. For South Salt Lake the required equalization storage was calculated according to the guidelines outlined by Utah Administrative Code R309-510-8. Storage requirements include an indoor component of 400 gallons per ERC and an outdoor component of 2,848 gallons per irrigated acre. Based on a value of 0.09 irrigated acres per ERC, the storage requirement for outdoor demands is 256 gallons per ERC. Combining the indoor and outdoor demands gives a total requirement of 656 gallons per ERC. The existing equalization storage requirement for South Salt Lake was found to be **4.16 MG**. Of that total 3.64 MG is required for Zone 1 and 0.52 MG is required for Zone 2. Because Zone 2 does not have any storage tanks, peak instantaneous flows to Zone 2 are supplied by the 900 West JVWCD connection.

TABLE IV-2
EXISTING WATER STORAGE REQUIREMENTS

PRESSURE ZONE	ERCs	REQUIRED STORAGE (MG)				EXISTING STORAGE (MG)	REMAINING (MG)
		EQUALIZATION (MG)	FIRE SUPP. (MG)	EMERG. (MG)	TOTAL (MG)		
1	5,542	3.64	1.50	1.03	6.17	7.00	0.83
2	795	0.52	1.00	0.30	1.82	0	-1.82
TOTAL	**6,337**	**4.16**	**2.50**	**1.33**	**7.99**	**7.00**	**NA[1]**

1. There is no means to convey adequate fire suppression flow from Zone 1 to Zone 2. For this reason the total "Remaining" value is reported as not applicable.

Fire Suppression Storage

Fire suppression storage is required for water systems that provide water for firefighting. The South Salt Lake Fire Department has jurisdiction over the City and the fire flow requirements in this master plan were set by the Fire Marshall, Boyd Johnson. The contact information for the South Salt Lake Fire department is as follows:

Phone: (801)483-4000

Address: 2600 S Main St
South Salt Lake, UT 84115

The minimum fire flow requirement for a building was **1,200 gpm for 4 hours.** Depending on the size of the building and the type of construction, higher flow requirements were assessed based on the International Fire Code and fire marshal recommendations. The required fire suppression storage for a given zone is determined by the building in the zone with the highest fire flow requirement. Granite Park Junior High School was assessed a required flow of **6,250 gpm for 4 hours** (1.5 MG), which was the largest requirement in Zone 1. In Zone 2, two industrial buildings at 2850 S 900 W and 2828 S 900 W were each assessed fire suppression flows of **4000 gpm for 4 hours**, which corresponds to a volume of about 1 MG. However, as stated previously, there are no storage tanks located in Zone 2. Moreover, JVWCD does not allow wholesale customers to consider JVWCD storage tanks in meeting fire storage requirements.

It is essential that the water system is managed so that the storage volume dedicated to fire suppression is available to meet fire flow requirements whenever or wherever it is needed. This can be accomplished by designating minimum storage tank water levels that provide reserve storage equal to the required fire suppression storage. Although it is important to utilize equalization storage, typical daily water fluctuations in the tanks should never be allowed below the minimum established levels except during fire or emergency situations. Fire suppression tank levels are included in Table IV-1. All of the fire suppression storage for Zone 1 has been assigned to the 1300 East Tank because it is the only tank within Zone 1 that can supply water via gravity flow.

Emergency Storage

DDW standards suggest that emergency storage be considered in the sizing of storage facilities. Emergency storage is intended to provide a safety factor that can be used in the case of unexpectedly high demands, pipeline failures, equipment failures, electrical power outages, water supply contamination, or natural disasters. Emergency storage has been assigned to each zone at a rate of 20% of the sum of the equalization volume and fire suppression volume.

BUILD-OUT STORAGE REQUIREMENTS

The storage volumes required at build-out are based on the same equalization, fire suppression, pump operation, and emergency storage requirements as were calculated for the existing conditions. The build-out equalization storage will be higher than existing conditions because the number of ERCs is projected to increase. However, similar to the source requirements, only indoor storage requirements have been considered for new future development. The indoor storage requirement is 400 gallons per ERC. Moreover, fire suppression volumes are not expected to increase. Instead, it is likely that the required fire suppression volume will be lower at build-out as a result of older buildings being replaced with newer buildings that meet updated building codes. However, because it is not known if, or when such upgrades will occur, the existing fire suppression volumes have been carried over to the build-out projections. Emergency storage was again calculated as 20% of the sum of the equalization volume and fire suppression volume. The City's future storage requirements at build-out are presented in Table IV-3.

TABLE IV-3
BUILD-OUT STORAGE REQUIREMENTS

ZONE	RECOMMENDED STORAGE REQUIREMENTS					EXISTING STORAGE (MG)	REMAINING (MG)
	ERCs	Equalization (MG)	Fire Suppression (MG)	Emergency (MG)	Total (MG)		
1	5,542 (Ex.) 6,340 (Fut.) 11,882	3.64 2.54 6.18	1.50	1.54	9.22	7.0	-2.22
2	795	0.52	1.00	0.30	1.82	0	-1.82
TOTAL	**12,677**	**6.70**	**2.50**	**1.84**	**11.04**	**7.0**	**-4.04**

EXISTING BOOSTER PUMPS

With the exception of the 1300 East Tank, the storage reservoirs in the South Salt Lake distribution network are not able to supply water via gravity flow. Booster pumping stations are needed to pump water out of the 300 East Tank, Bolinder Tank, and Davis Tank and into the supply network. The 300 East and Davis Booster Stations pump water into Zone 1. Davis Booster Station also includes pumps to Zone 2. When operable, Bolinder Booster Station supplies water to Zone 1; however, as with other Bolinder facilities, the Bolinder booster station in not currently in use because the well is out of service. Data regarding the booster pumps was obtained through communication with South Salt City personnel and is presented in Table IV-4.

TABLE IV-4
BOOSTER PUMP CHARACTERISTICS

FACILITY	BOOSTER PUMP DATA		NOTES
	POWER (HP)	CAPACITY (gpm)	
300 East Booster 1 Booster 2	 40 75	 700 800	Normally only one booster pump is on, usually the smaller pump.
Bolinder Booster 1 Booster 2	 50 50	 600 600	Not currently in use.
Davis Booster 1 Booster 2 Booster 3	 100 100 75	 1,200 1,200 850	Normally only one booster is on at a time.
West Davis Booster 1	 No Data	 400	No recent data for this pump. The pump serves as a redundant source for the 900 West JVWCD connection.

In order to make full use of a drinking water source capacity, storage tanks and booster pumps that are associated with wells should be sized based on the capacity of the well. For example, 300 East Well, with a capacity of 725 gpm is able to provide for the peak day demand of 795 ERCs (725 gpm ÷ 0.912 gpm/ERC). The tank should have at least enough capacity to provide equalization storage for the ERCs the well can serve. For South Salt Lake, the required storage is 656 gallons per ERC, which results in a required equalization volume of about 0.52 MG for the 300 East Tank. Similarly, booster pumps should be sized to provide the peak instantaneous demand for the ERCs a well serves. The existing peak instantaneous demand for South Salt Lake is 1.459 gpm per ERC which gives a required capacity of 1,160 gpm for the 300 East Booster Station. Similar calculations were completed for all of the facilities where a well feeds directly into a storage tank and the results are displayed in Table IV-5.

TABLE IV-5
STORAGE AND BOOSTER RECOMMENDATIONS

FACILITY	WELL CAPACITY (gpm)	ERCs SERVED	STORAGE (MG)	BOOSTER (gpm)
300 East	725	795	0.52	1,160
Bolinder	2,000	2,193	1.44	3,200
Davis	2,900	3,180	2.09	4,640

It was assumed that the existing rated capacity of the pumps is equal to the sum of the individual pump capacities, minus the capacity of the largest pump. Although not currently operational, the Bolinder facilities have been included for completeness and because it is recommended to drill a new well in the same general location. Sizing of the storage and booster facilities at Bolinder well should be reviewed if or when the new well is completed and the source capacity is known. However, based on the previous capacity of Bolinder Well, an additional storage volume of 0.44 MG will be required. In order to provide peak instantaneous flows the booster station will need an additional capacity of 2,600 gpm.

With regard to the facilities that are currently in use, the 300 East Tank is large enough to provide peak day equalization storage with about 0.48 MG of extra storage that could be considered emergency or fire suppression storage. Conversely, Davis Tank is slightly undersized with respect to equalization storage. Nonetheless, the deficiency is small enough that adding additional equalization storage would be impractical. The 300 East booster station includes two pumps. The larger pump has a reported capacity of 800 gpm while the smaller pump has a capacity of about 700 gpm. Although capacities of the two pumps sum to 1,500 gpm, which is greater than the required value of 1,160 gpm, redundancy should be incorporated such that the pump station can supply the flow with the largest pump out of service. Therefore, an additional 460 gpm of capacity is recommended for the 300 East pump station. The Davis Booster Station includes two 1,200 gpm pumps and one 850 gpm pump. In order to provide the recommended capacity with the largest pump offline, an additional capacity of 2,590 gpm would be needed.

BOOSTER PUMP AND STORAGE RECOMMENDATIONS

South Salt Lake City currently has 7.0 MG of storage, all located in Zone 1. Under existing conditions there is an adequate volume of storage to provide equalization, fire suppression, and emergency needs in Zone 1. However, based on the evaluations of the booster stations, the equalization storage in Davis Tank is not useable and a portion of the equalization storage in 300 East Tank has no provision for redundancy. The 300 East Booster Station requires an additional 460 gpm of capacity, and the Davis Booster Station an additional 2,590 gpm of capacity. Therefore, it is recommended that additional pump capacity be added to both booster stations. Upsizing the existing booster facilities may be possible and should be explored as an option. However, since it is not clear whether upsizing the existing facilities is feasible, the cost estimates presented later assume that new pump stations will be built to replace the existing pump stations. It is recommended that the rated capacity of the proposed 300 East Booster Station should be 1,160 gpm. A rated capacity of 4,640 is recommended for the Davis Booster Station. In addition, if Bolinder Well is replaced, additional facilities will be needed at that location in order to take advantage of the expected 2,000 gpm well capacity. It is expected that the storage at Bolinder Tank will need to be expanded by about 0.5 MG and that a new pump station, with a flow rate of 3200 gpm, will be required. However, improvements to Bolinder facilities should be completed only after the well has been constructed and the capacity of the well is known.

Zone 1 has a build-out storage requirement of 9.22 MG, giving a build-out deficit of 2.22 MG. Reactivating Bolinder Tank (currently 1 MG) and increasing the storage at the location by 0.5 MG, cuts the build-out deficit to 0.72 MG. In order to provide the required storage it is suggested that a new Zone 1 storage facility be considered with a volume of about 1.00 MG. It is proposed that the extra capacity should be added at the location of the existing 1300 East Storage Tanks, if possible. An additional option for eliminating the storage deficit is to accept a reduction in emergency storage. Utah Administrative Code R309-105-8(4) requires consideration of emergency storage; however, no explicit guidelines regarding the required emergency storage volume are provided. Instead, the following guidance is offered:

> It is advisable to provide water storage for emergency situations, such as pipeline failures, major trunk main failures, equipment failures, electrical power outages, water treatment facility failures, raw-water supply contamination, or natural disasters. Generally, the need for emergency storage shall be determined by the water supplier and design engineer.

Based on conversations with City personnel, an emergency storage volume equal to 20% of the combined equalization and fire flow storage volumes has been recommended. Past experience has indicated that Utah State Standards for equalization storage are generally quite conservative. For this reason, additional emergency storage is not always needed. If the future emergency storage requirement is reduced to 10% of the combined equalization and fire storage volumes, the additional storage suggested at the location of the 1300 East Storage Tanks becomes unnecessary.

Two options have been identified that will allow the City to provide fire storage to Zone 2. The first option is for the City to utilize the existing Salt Lake City connection located at 2775 S 900 W. Communication with City personnel indicates that the connection to South Salt Lake is 12-inches. In addition, South Salt Lake provided fire flow test records to HAL during the process of preparing this master plan. The records show that a fire flow test was conducted by Insurance Services Offices, Inc. at 2600 S 900 W, just north of the Salt Lake City connection. Fire flows at that location were provided by the Salt Lake distribution system and total 4,800 gpm. Based on this data, it is probable that the Salt Lake City connection could provide the 4,000 gpm fire flow that is required in Zone 2. In order to use this fire flow, South Salt Lake would need to enter into an agreement with Salt Lake City. Salt Lake City would need to agree to provide the flow and also 1 MG of fire suppression storage. An automatic valve would need to be installed at 2775 S 900 W that would open if pressures dropped in the South Salt Lake system due to emergency flows.

A second option for providing fire flows and fire suppression storage to Zone 2 would be to add a connection at Davis Tank that would allow water to flow from Zone 1 to Zone 2 if the pressure in Zone 2 dropped due to a fire event. In addition to adding the connection, the transmission lines connecting Davis Tank to Zone 1 would need to be upsized and a parallel line would need to be installed between Davis Tank and 900 West. State Street acts as a bottle neck for water moving from the 1300 East tank to the west side of the distribution system. For this reason, an additional connection across State Street will be needed. Additional details are provided under the “Capital Improvements” portion of this master plan. It is assumed within this master plan that the City will continue to use the JVWCD connection at 900 West to supply peak instantaneous flow rates to Zone 2. Therefore, JVWCD provides the equalization storage for Zone 2.

CHAPTER V

DISTRIBUTION SYSTEM

EXISTING DISTRIBUTION SYSTEM

The distribution system consists of all pipelines, valves, fittings, and other appurtenances used to convey water from the water sources and storage tanks to the water users. The existing water system contains over 50 miles of distribution pipe ranging in size from 2 to 24 inches in diameter. Figure V-1 presents a summary of pipe length by diameter.

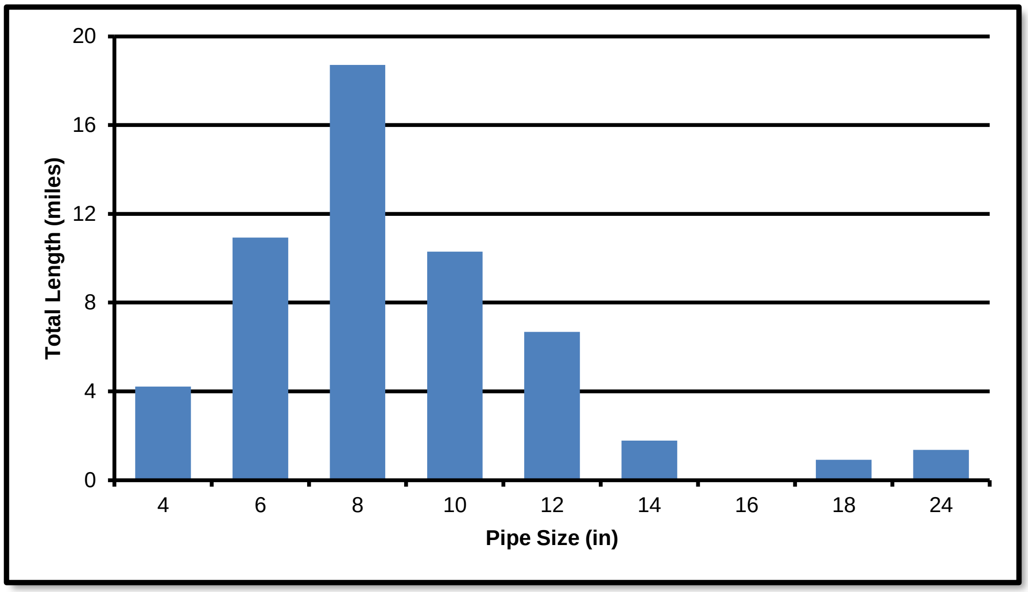


FIGURE V-1: SUMMARY OF PIPE LENGTH BY DIAMETER

Two pressure zones exist in South Salt Lake City. Zone 1 is in a physically separate system from Zone 2. The existing distribution system is shown in Figure I-1.

EXISTING DISTRIBUTION SYSTEM REQUIREMENTS

Utah Administrative Code R309-105-9(1) applies to existing systems approved prior to January 1, 2007 and requires that distribution systems be able to maintain a minimum of 20 psi at all points in the system during normal operating conditions and during conditions of fire flow and peak day demand. R309-105-9(2) adds the following minimum water pressure constraints: (a) 20 psi during conditions of fire flow and fire demand experienced during peak day demand; (b) 30 psi during peak instantaneous demand; and (c) 40 psi during peak day demand. R309 105-9(2) applies to new systems approved after January 1, 2007 and to new areas or subdivisions of existing systems. Much of South Salt Lake City is subject only to R309-105-9(1); however, new developments will need to meet the criteria outlined by R309-105-9(2). The City further prefers that the distribution system maintain pressures between **50 and 110 psi** at all points in the system under normal operating conditions, including Peak Instantaneous, Peak Day, and Average Day.

Existing Peak Instantaneous Demand

Peak instantaneous demand is the highest demand on the peak day. The pipes in the distribution system must be large enough to convey the peak instantaneous demand while maintaining a pressure at connections between 50 and 110 psi. The peaking factor from the peak day average flow to peak instantaneous flow was estimated to be 1.6 at 3:40 a.m. based on flow data out of the tank on June 16th-18th 2010 (see Figure III-2). Applying this peaking factor of 1.6 to the peak day demand gives a total existing peak instantaneous demand of **9,246 gpm**.

Existing Peak Day Plus Fire Flow Demand

In accordance with DDW regulations, the distribution system must be capable of delivering fire flow to a specified location within the system while supplying the peak day demand to the entire distribution system and maintaining 20 psi minimum pressure at all delivery points within the distribution system. A minimum fire flow demand of **1,200 gpm** or more is required for all demand nodes in the system. Larger fire flows are required at larger structures throughout the system based on the International Fire Code and recommendations from the South Salt Lake City Fire Marshall. As noted above, Granite Park Junior High School was assessed a required flow of **6,250 gpm for 4 hours**, which was the largest requirement in Zone 1. The highest Zone 2 requirement was **4,000 gpm for 4 hours**, assessed to two industrial buildings at about 2850 S 900 W and 2828 S 900 W. All fire flows were simulated under peak day demand conditions (see Chapter III for a complete explanation of peak day demand).

BUILD-OUT DISTRIBUTION SYSTEM REQUIREMENTS

The existing system requirements apply to the projected build-out system as outlined previously. Similar to existing conditions, the build-out system was evaluated based on the City's preferences of 50 psi and 110 psi for minimum and maximum pressures.

Build-Out Peak Instantaneous Demand

Assuming the same peaking factor of 1.6 applies to the build-out peak day demand gives a peak instantaneous demand of **14,882 gpm**.

Build-Out Peak Day Demand Plus Fire Flow

The distribution network was also simulated using build-out demands in order to identify the improvements that will be necessary with future City development. The build-out system was evaluated using the same criteria as the existing system (R309-105-9(2) and City preference). The following sections outline the demand requirements for the build-out system.

COMPUTER MODEL

A computer model of the City's water distribution system was developed to analyze the performance of the existing and future distribution system and to prepare solutions for existing facilities that cannot meet the DDW or City criteria for water system pressures. The software used for the model was EPANET 2.0. EPANET 2.0 is a computer program that models the hydraulic behavior of piping networks. The pipe, tank, and valve data used to develop the model were obtained from a previous model of the South Salt Lake City water system and updated according to information supplied by the City. The previous model of the South Salt Lake City water system was a steady state model, while the model of the water system developed for this Master Plan is an extended period model. System controls were provided by the City in order to correctly model the on and off triggers for sources and valves.

Computer models were developed for three phases of water system development. The first phase was the development of a model of the existing system (existing model). This model was used to calibrate the model and identify deficiencies in the existing system. A second model was developed which was used to identify those corrections necessary to improve existing system deficiencies (corrected existing model). The third phase was the development of a future model to indicate those improvements that will be necessary for the projected “build-out” condition (future model).

MODEL COMPONENTS

The two basic elements of the computer model are pipes and nodes. A pipe is described by its inside diameter, overall length, minor friction loss factors, and a roughness value associated with friction head losses. A pipe can include elbows, bends, valves, pumps, and other operational elements. Nodes are the end points of a pipe and they can be categorized as junction nodes or boundary nodes. A junction node is a point where two or more pipes meet, where a change in pipe diameter occurs, or where flow is put in or taken out of the system. A boundary node is a point where the hydraulic grade is known (a reservoir or PRV).

The computer model of the water distribution system is not an exact replica of the actual water system. Pipeline locations used in the model are approximate and every pipeline may not be included in the model, although efforts were made to make the model as complete and accurate as possible. It is not necessary to include all of the distribution system pipes in the model to accurately simulate its performance.

Pipe Network

As indicated previously, the pipe network layout was based upon the model prepared for South Salt Lake City's previous drinking water master plan. Updates to the model were made from maps and drawings provided by the City.

Demands

Water demands were input into the water system model by flow in gallons per minute. Existing and Future water demand was assigned to nodes in the model which best represented the location of the demand. Demand data sets were created in the model for the appropriate demand conditions for each scenario. The data sets include the average demand according to the billing data between September 2008 and September 2010, the State Standards for the existing system, and the State Standards for the build-out system. In the extended period model scenarios, the model runs for 24 hours or more and the demand changes over time according to the diurnal curve defined by Figure III-1.

Sources, Storage Tanks, and Booster Stations

The sources of water in the model are the wells and connections with the JVWCD water system. The levels in the tanks are modeled in the extended period model scenario. Several of the South Salt Lake wells feed directly into tanks with booster stations needed to pump water out into the distribution network. The extended period model predicts the levels in the tanks as they fill from sources and as water is pumped out to meet demand in the system.

MODEL CALIBRATION

A water system computer model should be calibrated before it may be relied on to accurately simulate the performance of the distribution system. Calibration is a comparison of the computer results, field tests, and actual system performance. Field tests are accomplished by performing fire flow tests and pressure tests on the system. When the computer model does not match the field tests within an acceptable level of accuracy, the computer model is adjusted to match field conditions. Calibration is especially useful for identifying pipe sizes that are not correct and PRVs or isolation valves that are not operating as expected. Pipe roughness is an additional characteristic which may also be adjusted during calibration. Many of the pipelines within the South Salt Lake distribution network have been in use for over 50 years. However, the City maintains an ongoing pipeline replacement program. Consequently, although many of the pipelines are old, a significant number of newer pipelines are also mixed in. Sufficient data for characterizing all of the pipes based on age and condition was not provided. For this reason, no attempt was made to characterize individual pipes; rather, all of the pipes in the distribution model were assigned a roughness of 0.003 feet (0.036 inches). This is a fairly large roughness and is most applicable to the older pipes with significant corrosion.

The model was calibrated successfully with the use of fire flow tests, pressure tests, and system performance information. Calibration results are included in Appendix C. In general, the static pressures in the model averaged about 15% lower in Zone 1 and 2% higher in Zone 2 as compared to measured values. Moreover, source utilization was also considered during the hydraulic calibration. Flow patterns from the South Salt City sources that were active during July and August of 2010 were compared against modeled sources. Included in the calibration were 700 East Well, Davis Well, 300 East Well, and the JVWCD connections. The overall flow patterns in the model matched the observed values very well (flow data is included in Appendix C). It is recommended that City staff continue to conduct fire flow tests on an ongoing basis and review SCADA information to refine the model calibration as system conditions change.

ANALYSIS METHODOLOGY

The EPANET 2.0 model was used to analyze the performance of the water system for current and projected future demands under three main operating conditions: low flow (highest pressure) conditions, peak instantaneous conditions, and peak day plus fire flow conditions. Each of these conditions put the water system into a worst-case situation so the performance of the distribution system may be analyzed for compliance with DDW and South Salt Lake City's requirements. The results of the model for each of the conditions are discussed below.

High Pressure Conditions

Low flow or static conditions are usually the worst case for high pressures in a water distribution system. In the wintertime, water demand during night time hours is very low, tanks are nearly full, and movement of water through the system is minimal. Under these conditions, the water system approaches a static condition and water pressure in the distribution system is dependent only upon the elevation differences and pressure regulating devices. Another condition similar to static condition that can also cause high pressures in the City's water system occurs in the summer when demand is low and pumps are on to fill storage tanks. During times of low demand, the pumps increase the pressure in the system high enough to reverse the flow coming from the tanks. The highest pressures are reached when pumps are on, tanks are almost full, and demand is low. Both of these high pressure conditions were simulated with the model. While modeling these scenarios, observed pressures were below the City's preferred maximum pressure of 110 psi.

Peak Instantaneous Demand Conditions

Peak Instantaneous demand conditions can sometimes be the worst-case scenario for low pressures throughout a water distribution system. The water system reaches peak instantaneous demand conditions during the hottest days of the summer when both indoor and outdoor water use is the highest. The high demand creates high velocities in the distributions pipes which reduces pressure. R309-105-9(2) requires the pipes in the distribution system to be capable of delivering peak instantaneous demand to the entire service area and maintain a minimum pressure of 30 psi at any service connection within the distribution system. Usually, minimum pressures of 30 psi at peak instantaneous demand are too low for customer satisfaction; hence, the City prefers a minimum pressure of 50 psi under this condition. Within the model of the existing system, minimum pressures were observed in the northeast portion of the system and reached as low as 58 psi. The future model, which includes build-out demands as well as recommended system improvements, had a low pressure of 47 psi. The low pressure in the future model was observed in the northeast area of the system. Due to the difficulties associated with projecting future demands, and because this modeled pressure is just less than the threshold set by South Salt Lake for minimum pressures, no projects to address this deficiency have been suggested at this time. Instead, it is recommended that the possibility of low pressures in that area should be reevaluated in future master plans.

Peak Day Demand Plus Fire Flow Conditions

Even though peak instantaneous conditions are the worst-case for the lowest pressure and highest demand for the entire system, the peak day plus fire flow is often the worst-case scenario for the lowest pressures for specific locations in the system. This condition occurs when fire hydrants are being used on a day of high water demand. The distribution system must be capable of delivering the required fire flow to the specified location within the system, while supplying the peak day demand to the entire distribution system. In accordance with the recommendations from the South Salt Lake City Fire Marshal, the required fire flows must be delivered while maintaining 20 psi minimum residual pressure at the delivery point and to all service connections within the distribution system.

Identifying every pipe which is not capable of supplying the required fire flow is beyond the scope of this study. While the computer analysis is useful for providing general indications of the fire flow capacity, it does not calculate the capacity at every fire hydrant, nor does it identify every water line where fire flow capacity is inadequate. The computer analysis checks fire flow capacity at model junction nodes which are generally placed at the intersections of two or more pipes. Fire flow capacity at fire hydrants between model nodes could be less than the computer analysis indicates. For this reason, the computer analysis should not replace physical fire flow tests at fire hydrants as the primary method of determining fire flow capacity.

The following fire flow deficiencies were identified in the in computer model:

1. Insufficient fire flow delivered to an office building at 180 E 2100 S.
2. Insufficient fire flow delivered to residential area along 400 E near 2100 S.
3. Fire hydrant at about 200 East Burton Avenue does not provide sufficient fire flow.
4. Insufficient fire flow delivered to industrial area at about 230 W 2700 S.
5. Insufficient fire flow delivered to South Salt Lake Police Athletic/Activities League .building at 2825 S 200 E and to Granite Park Junior High at 3031 S 200 E.
6. Dead-end 4-inch pipeline in Angelo Avenue between West Temple and 200 W provides insufficient fire flows.
7. Inadequate fire flow delivered to a residential area along 300 E near 2100 S.
8. Insufficient fire flow capacity to fire hydrant on Richards Street.
9. Inadequate fire flow delivered along Walton Avenue.
10. Insufficient fire flow delivered to an industrial building at about 2115 S 400 W.
11. Insufficient fire flow in Zone 2.

Specific recommendation to address these deficiencies are included below under the heading “Distribution System Recommendations”.

Peak Day Extended Period

The peak day extended period model was used to model the water system performance over time. An extended period model is actually a static model run several times for each time period, like a movie is made up of individual pictures put together. The peak day extended period model was used to set system conditions for the static models, calibrate zone to zone water transfers, analyze system controls and the performance of the system over time, analyze system recommendations for performance over time, and analyze the water system for optimization recommendations. The peak day extended period model was run for several days with the peak day demand curve repeating every 24 hours such that the model operated in a stable pattern. The model has reached stabilization when the filling and emptying cycles of the tanks repeat in a consistent pattern without running empty. System recommendations for existing conditions and future conditions at build-out were checked with the extended period model to confirm adequacy.

The primary deficiency identified during the extended period modeling was relatively high flow velocities in the pipes connecting the Davis Pump Station to Zone 1. The high velocities lead to high head loss within the pipes. This deficiency is addressed below by projects outlined within the “Distribution System Recommendations” section. The deficiency is not addressed individually, but instead is corrected by the projects included for providing fire flow to Zone 2.

MODEL OUTPUT

The model output primarily consists of the computed pressures at nodes and flow rates through pipes. The model also provides additional data related to pipeline flow velocity and head loss to help evaluate the performance of the various components of the distribution system. Results from the model are available on a CD in Appendix D. Due to the large number of pipes and nodes in the model, it is impractical to prepare a figure which illustrates pipe numbers and node numbers. The reader should refer to the CD to review model output.

CONTINUED USE OF THE COMPUTER PROGRAM

It is recommended that the City continue updating the model as the water system changes. Below is a list of ways in which the model could help the City with water system management. The computer model can assist City staff in determining:

- Effect on the system if individual facilities are added or taken out of service
- Selection of pipe diameters and location of proposed water mains
- Capacity of the water system to provide fire flows in specific areas
- Water age for water quality monitoring
- Residual chlorine and fluoride levels in the system

The computer model should be maintained for future use. Necessary data required for continued use of the program are:

- The location , length, diameter, pipe material, and ground elevation at each end of each new pipeline constructed
- Changes in water supply location and characteristics
- Location and demand for new large customers
- Changes in chlorine and fluoride dosing rates and procedures

DISTRIBUTION SYSTEM RECOMMENDATIONS

Distribution system recommendations provide solutions for existing deficiencies and define improvements to provide capacity for projected future growth. Projects have been divided into two groups. Group one includes general project recommendations. Group two includes all projects specifically developed for providing fire flow to Zone 2. The general project recommendations are included in Table V-1. The Zone 2 project recommendations are included in Table V-2. Conceptual level costs for the proposed projects are presented in Chapter VI.

TABLE V-1
PROPOSED GENERAL IMPROVEMENT PROJECTS

LOCATION	ELEMENT ID	PROBLEM DESCRIPTION	PREFERRED SOLUTION
180 East 2100 South	J-264	Insufficient fire flow	Add a fire hydrant just to the south near the corner of Commonwealth Ave. and 200 East
400 East from Utopia Ave. to 2100 South	J-49	Insufficient fire flow	Replace existing pipe with an 8” pipeline in 400 East from Utopia Ave. to 2100 South
Burton Ave. from 200 East to 300 East	P-71	Insufficient fire flows	Replace existing pipe with an 8” pipeline in Burton Ave. from 200 East to 300 East
2700 South 230 West	P-125	Insufficient fire flows and aging pipe behind industrial buildings	Replace existing pipe with a 10” pipeline in the alley at approximately 230 West from 2700 South to approximately 2620 South
200 East from Gregson Ave. to Sunset Ave.	P-500, P-499, P-480, P-479, P-596, P-597, P-557, P-374, P-591, P-546, P-547, P-545	Insufficient fire flows	Replace existing pipe with a 10” pipeline in 200 East from Gregson Ave to Sunset Ave.
150 W Angelo Ave.	P-414	Insufficient fire flows	Replace existing pipe with an 8” pipeline in Angelo Ave from West Temple to approximately 200 West
300 East from 2100 South to Commonwealth Ave.	P-252	Insufficient fire flows	Replace existing pipe with an 8” pipeline in 300 East between 2100 South and Commonwealth Ave.
Andy Ave. from 600 West	P-395, P-42, P-43, P-45	High velocity and head loss, insufficient fire flows at industrial building at 2115 S 400 W	Install a parallel 12” pipeline in Andy Ave. from 600 West to 300 West alongside the existing 10” pipeline. In addition, requires improvements to Bolinder Well, Tank, and Pump Station.
Richards Street from 3222 South to 3200 South connecting over to West Temple	P-399	Insufficient fire flows	Replace existing pipe with an 8” pipeline in Richards St. and connecting over to West Temple
Walton Ave from West Temple to 300 West	P-186	Insufficient fire flows	Replace existing pipe with a 10” pipeline in Walton Ave.

TABLE V-2
PROPOSED ZONE 2 FIRE FLOW IMPROVEMENT PROJECTS

LOCATION	ELEMENT ID	PROBLEM DESCRIPTION	PREFERRED SOLUTION
Through parking lot at about 2920 South from 300 West to 400 West, In 400 West from 2920 South to 2970 South, Under I-15 from 400 West to the existing Davis Booster Station	P-164, P-162, P-433	Insufficient conveyance from Zone 1 to Davis Booster Station	Replace existing pipelines with a 16-inch pipeline
South from Davis Pump Station in 465 West to about 3180 South, southwest across train tracks following existing 12-inch line to Central Valley Road, in Central Valley Road from 650 West to about 850 West, in 850 West from Central Valley Road to 3100 South, in 3100 South from 850 West to 900 West	P-444, P-5, P-449	Insufficient conveyance from Davis Booster Station to Zone 2	Install parallel 16-inch pipeline alongside existing 12-inch pipeline
North from 3100 South along 900 West to 2780 South	P-434	Insufficient conveyance along 900 W	Install parallel 18-inch pipeline in addition to existing 14-inch pipeline
Intersection of State Street and Truman Ave.	N/A	High velocities in pipelines along State Street	New connection across State Street
In 3160 South from 900 West to 1030 West, and in 1030 West from 3160 South to 3120 South	27	Inadequate fire flow to industrial buildings at 3120 S 1030 W	Install a parallel 10-inch pipeline in 3160 S and 1030 W

CHAPTER VI

WATER QUALITY

One advantage of the EPANET extended period model is the ability to model water quality. Water age, disinfection byproduct potential, chlorine residual, and fluoride concentration were modeled to analyze the existing water system for water quality issues.

WATER AGE AND DISINFECTION BYPRODUCT EVALUATION

The extended period model was used to predict the areas in the water system that have the highest potential for disinfection by-product (DPB) production. The month that typically has the highest DBP levels in Utah is October and DBP testing has confirmed this to be true for the City's water system. This is because the water is still relatively warm and water use is less than during the summer. The potential for DBP production is higher in warmer and older water. Water demand for October 2008 was used to simulate water demand conditions in the model. Water age was then calculated for every location in the system by running the model to simulate several days in October. The locations having poor circulation and thus the oldest water were identified as having the highest potential for DBP production. Figure VI-1 on the following page illustrates a snapshot of the results of the water age model scenario run for 96 hours. The water age at a given location varies depending on the operating condition of the distribution network. For example, as a pump turns on, new water is pushed out into the system. This is illustrated by the light and dark blue in the areas around 700 East Well and Davis well. On the other hand, the water coming from the 1300 East Tank is considerably older. Dead end lines with low demands also tend to have older water. Based on the model results, DBP testing should focus on the northeast area of the system. This area is fed predominantly by the 1300 East Tank with minor contributions from other sources.

CHLORINE RESIDUAL EVALUATION

Chlorine residual is the amount of free chlorine remaining in the water at the time of the test. While chlorine is an effective disinfectant in controlling many microorganisms in drinking water, it reacts with organic material found in drinking water to form potentially harmful disinfection byproducts (DBPs) as it decays. Although the risk of becoming ill from microbial pathogens is tens of thousands of times greater than the risk of becoming ill from DBPs, it is enough of a concern that the Environment Protection Agency (EPA) has developed rules to balance the risks between microbial pathogens and DBPs. A drinking water system needs enough chlorine to destroy pathogens but also not produce excessive DBPs. Chlorine dosing rates were set at the sources of water in the system. The chlorine dosing concentrations assumed for each source are shown in Table VI-1.

Chlorine residuals are influenced by how much organic material is in the water. Therefore, modeling chlorine residuals requires calibration using system specific data. Chlorine decay was modeled as a first order reaction with a bulk coefficient of -1.0 per day. This bulk rate coefficient was selected based on comparisons with the field data using a sampling of 19 chlorine residual field test sites from the spring of 2008 (refer to Appendix E for tabular water quality data).

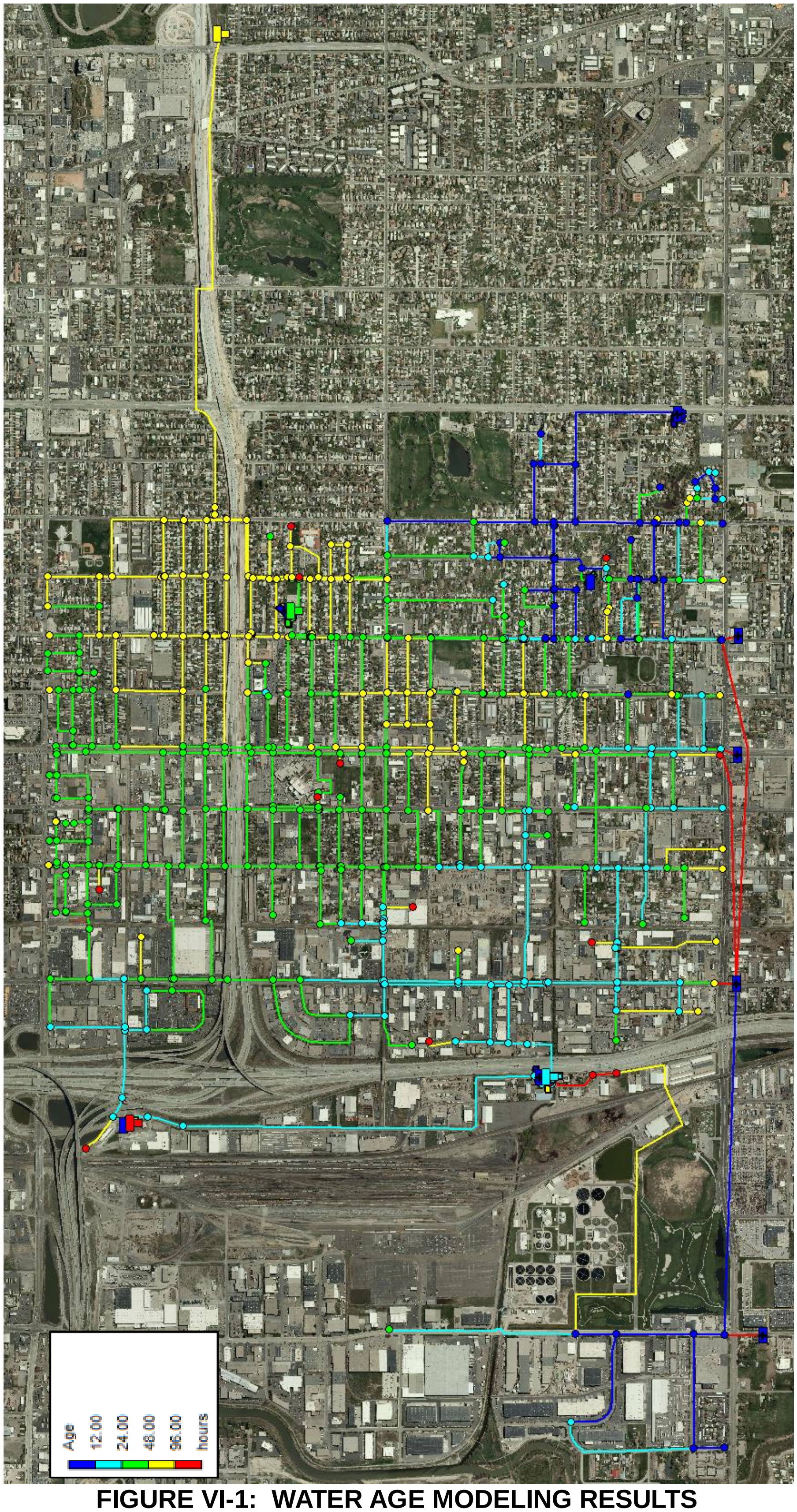


FIGURE VI-1: WATER AGE MODELING RESULTS

TABLE VI-1
DOSING CONCENTRATIONS ASSUMED AT SOURCES

SOURCE	CHLORINE CONCENTRATION (mg/L)
Davis Well	0.27
300 E Well	0.18
700 E Well	0.18
900 W JVWCD	0.14
300 W JVWCD	0.20
State St JVWCD	0.13
300 E JVWCD	0.13

The model was run sufficiently long for the chlorine residual to stabilize into a recurring daily pattern. Three days of model run time was generally adequate to reach this state of pseudo-equilibrium, depending on the water demand. Total chlorine residual test results from South Salt Lake and Central Valley Laboratory were used to calibrate the model with a demand set from October. The month of October was selected because low flows commonly occur during that month. As a result of the low flows, residence times in drinking water storage tanks are high, leading to low residual concentrations. Model results are shown in Figure VI-2 and generally follow the same pattern as water age. Higher concentrations of chlorine residual were found in areas around wells while lower concentrations were found in areas fed primarily by storage tanks where the water is stored for long periods of time, or in areas with low demand where the amount of time for the water to travel from source to demand is excessive. Figure VI-3 presents a comparison between field test and modeled chlorine residuals.

Some of the same areas that indicated the oldest water from the DBP model also have the lowest chlorine residuals. This suggests that improving the circulation of water will increase chlorine residuals and reduce DBPs. Several methods exist for increasing circulation within a distribution system. Often, two of the most practical are: strategic operation of drinking water sources and maximizing the use of equalization storage in the storage tanks. Both options require minimal capital investment while offering the potential to reduce chlorine and DBP issues. The drinking water model is a valuable tool in identifying source production patterns which promote circulation. New transmission lines are an additional option which can increase circulation if properly planned. If improvement to circulation is not able to resolve water quality issues, an additional possibility would be to install mechanical mixing or chlorine dosing at the larger storage tanks.

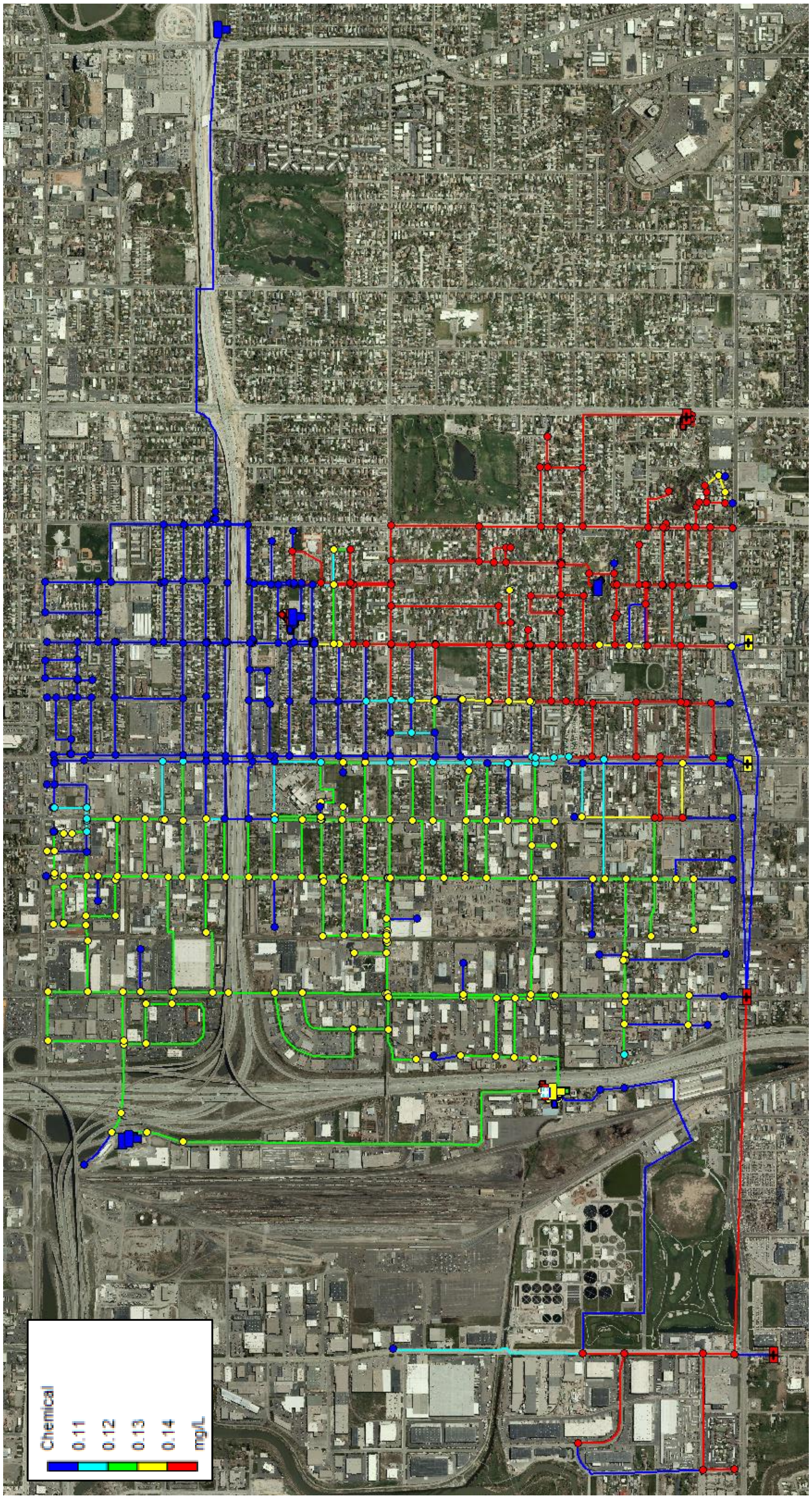


FIGURE VI-2: CHLORINE RESIDUAL MODELING RESULTS

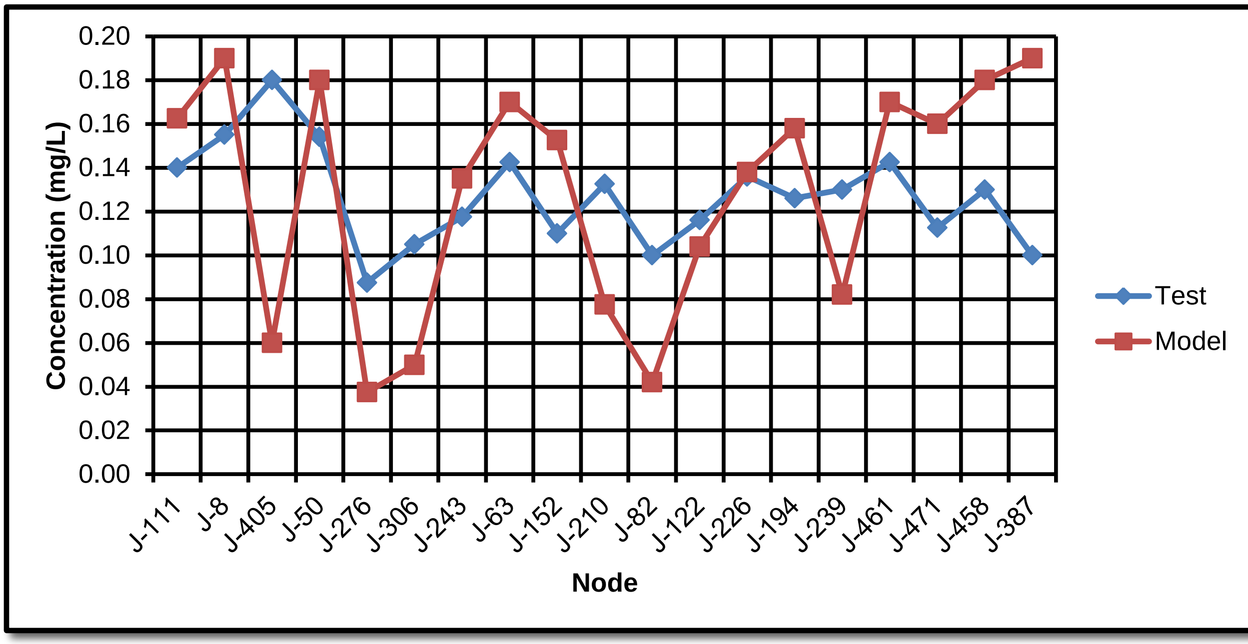


FIGURE VI-3: FIELD TEST VS. MODELED CHLORINE

SUMMARY OF WATER QUALITY RECOMMENDATIONS

Based on the field test results and the water quality model, circulation appears to generally be adequate within the South Salt Lake system. More specifically, areas in close proximity to wells generally had very good circulation. Conversely, the northeast area of the system appears to be the most susceptible to water quality issues. Demands are fairly low in this area and water is provided almost exclusively by the 1300 East Tank. Due to the size of the 1300 East Tank it is particularly important that the equalization storage in the tank be utilized in order to promote mixing in the tank. The following general recommendations are offered:

1. Continue to monitor water quality test results. If problem areas are identified, use the water quality model to determine source production patterns which promote water circulation.
2. Maximize the use of equalization storage in the storage tanks.

Many water quality problems can be effectively dealt with at a low cost by applying the above recommendations. Additional options for managing water quality include installing new pipelines to complete loops on dead end pipelines and applying mixing technologies to storage tanks.

CHAPTER VII

CAPITAL IMPROVEMENTS PLAN

Throughout the master planning process, the three main components of the City's water system (source, storage, and distribution) were analyzed to determine the system's ability to meet existing demands and also the anticipated future demands at build-out. Each of the system deficiencies identified in the master planning process and described previously in this report were presented in an alternatives workshop with City staff. Possible solutions were discussed for each of the identified system deficiencies as well as possible solutions for maintenance and other system needs not identified in the system analysis. After the workshop, HAL studied the feasibility of the solution alternatives and developed conceptual costs.

One important method of paying for system improvements is through impact fees. Impact fees are collected from new development and should only be used to pay for system improvements related to new development. For this reason it is important to identify which projects are related to resolving existing deficiencies, and which projects are related to providing anticipated future capacity for new development.

PRECISION OF COST ESTIMATES

When considering cost estimates, there are several levels or degrees of precision, depending on the purpose of the estimate and the percentage of detailed design that has been completed. The following levels of precision are typical:

Type of Estimate	Precision
Master Planning	±50%
Preliminary Design	±30%
Final Design or Bid	±10%

For example, at the master planning level (or conceptual or feasibility design level), if a project is estimated to cost $1,000,000, then the precision or reliability of the cost estimate would typically be expected to range between approximately $500,000 and $1,500,000. While this may seem very imprecise, the purpose of master planning is to develop general sizing, location, cost, and scheduling information on a number of individual projects that may be designed and constructed over a period of many years. Master planning also typically includes the selection of common design criteria to help ensure uniformity and compatibility among future individual projects. Details such as the exact capacity of individual projects, the level of redundancy, the location of facilities, the alignment and depth of pipelines, the extent of utility conflicts, the cost of land and easements, the construction methodology, the types of equipment and material to be used, the time of construction, interest and inflation rates, permitting requirements, etc., are typically developed during the more detailed levels of design.

At the preliminary or 30% design level, some of the aforementioned information will have been developed. Major design decisions such as the size of facilities, selection of facility sites, pipeline alignments and depths, and the selection of the types of equipment and material to be used during construction will typically have been made. At this level of design the precision of the cost estimate for a $1,000,000 project would typically be expected to range between approximately $700,000 and $1,300,000.

After the project has been completely designed, and is ready to bid, all design plans and technical specifications will have been completed and nearly all of the significant details about the project should be known. At this level of design, the precision of the cost estimate for the same $1,000,000 project would typically be expected to range between approximately $900,000 and $1,100,000.

SYSTEM IMPROVEMENT PROJECTS

As discussed in previous chapters, several source, storage and distribution system deficiencies were identified during the system analysis. Project costs for water system improvements are presented in Table VII-1 with the location of each project shown in Figure VII-1. Each recommendation includes a conceptual cost estimate for construction.

Unit costs for the construction cost estimates are based on conceptual level engineering. Sources used to estimate construction costs include:

1. "Means Heavy Construction Cost Data, 2013"
2. Price quotes from equipment suppliers
3. Recent construction bids for similar work

All costs are presented in 2013 dollars. Recent price and economic trends indicate that future costs are difficult to predict with certainty. Engineering cost estimates provided in this study should be regarded as conceptual level for use as a planning guide. Only during final design can a definitive and more accurate estimate be provided for each project. A cost estimate calculation for each project is provided in Appendix F and Table VII-1 provides a cost summary for the recommended system improvements.

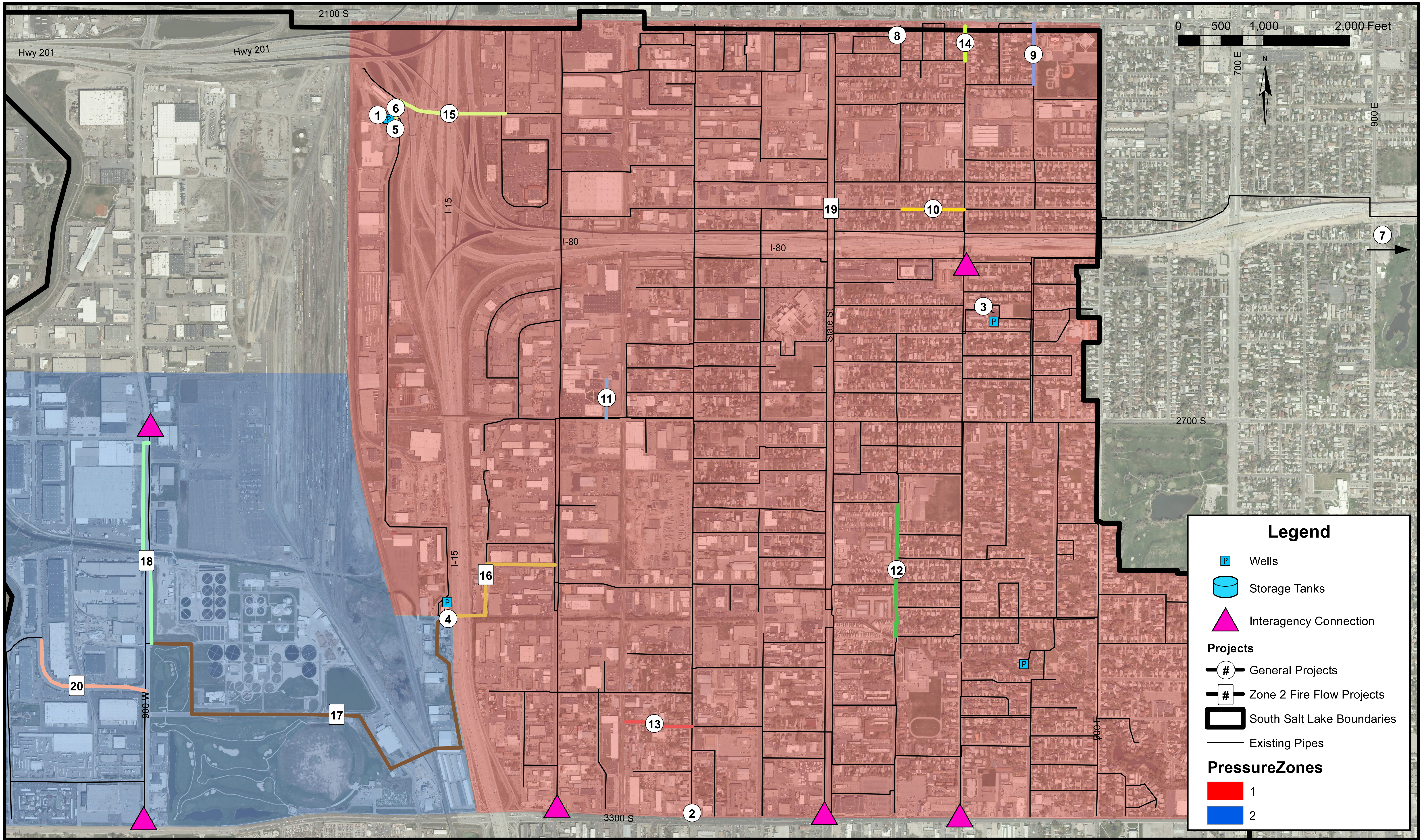
TABLE VII-1
PROJECT COSTS FOR SYSTEM IMPROVEMENTS

TYPE[1]	MAP ID	RECOMMENDED PROJECT[2]	COST
Existing	1	Construct a replacement for Bolinder Well	$945,000
Future	NA	Construct a new Zone 1 well	$945,000
Future	2	Install a new JVWCD connection at 3300 South West Temple	$41,000
Existing	3	Construct a new booster pump station with a rated capacity of 1,160 gpm at the 300 East Tank	$540,000
Existing	4	Construct a new booster pump station at Davis Tank, with a capacity of 4,640 gpm	$1,080,000
Existing	5	Expand the existing Bolinder Tank by 0.5 MG by either building a new 0.5 MG Tank, or by replacing the existing 1.0 MG tank with a 1.5 MG tank (cost estimate for new 0.5 MG tank)	$540,000
Existing	6	Construct a new booster pump station at Bolinder Tank, with a rated capacity of 3,200 gpm	$844,000
Future	7	Construct a new 1.0 MG Zone 1 storage facility by the existing 1300 East Tanks	$1,080,000
Existing	8	Install fire hydrant at 200 East and approximately 2115 South	$7,000
Existing	9	Replace existing pipe with 725 feet of 8" pipeline in 400 East from Utopia Ave. to 2100 South	$90,000

TYPE[1]	MAP ID	RECOMMENDED PROJECT[2]	COST
Existing	10	Replace existing pipe with 725 feet of 8" pipeline in Burton Ave. from 250 East to 300 East	$90,000
Existing	11	Replace existing pipe with 450 feet of 10" pipeline in the alley at approximately 230 West from 2700 South to approximately 2620 South	$63,000
Existing	12	Replace existing pipe with 1,550 feet of 10" pipeline in 200 East from Gregson Ave. to Sunset Ave.	$216,000
Existing	13	Replace existing pipe with 785 feet 8" pipeline in Angelo Ave. from West Temple to approximately 200 West	$97,000
Existing	14	Replace existing pipe with 410 feet of 8" pipeline in 300 East from 2100 South to Commonwealth Ave.	$51,000
Existing	15	Install 1,465 feet of 12" pipeline in Andy Ave. between 600 West and 300 West parallel to the existing 10" pipeline. This project addresses a fire Flow deficiency at 2115 W 400 S. In order to fully address the deficiency, projects 1, 5, and 6 must also be completed.	$229,000
Existing	16	Install 1,900 feet of new 16" pipeline parallel to existing pipeline, through parking lot at about 2920 S from 300 W to 400 W, in 400 W from 2920 S to 2970 S, Under I-15 from 400 West to the existing Davis Booster Station	$333,000
Existing	17	Install 6,500 feet of new parallel 16" pipeline south from Davis Pump Station in 465 W until about 3180 S, southwest across train tracks following the existing 12-inch line to Central Valley Road, in Central Valley Road from 650 W to about 850 W, in 850 W from Central Valley Road to 3100 S, and in 3100 S from 850 W to 900 W	$1,365,000
Existing	18	Install 2,480 feet of 18" pipeline along 900 W from 3100 S to 2780 S	$525,000
Existing	19	Connection across State Street at intersection of State Street and Truman Ave	$68,000
Existing	20	Install 1,740 feet of 10" pipeline parallel to the existing pipeline in 3160 S from 900 W to 1030 W, and in 1030 W from 3160 S to 3120 S	$242,000
Total			**$9,391,000**

1. Projects categorized as "Existing" are needed to address existing system deficiencies. "Future" projects address deficiencies which are projected to occur in the future based on growth and demand projections.
2. See descriptions in the source, storage and distribution system recommendation summaries presented in previous chapters.

All existing system improvement projects are recommended to be completed in 0 to 5 years. The total estimated cost of projects which address existing deficiencies is $7,325,000. Projects which address future deficiencies sum to $2,066,000.



HANSEN ALLEN & LUCE INC ENGINEERS

SOUTH SALT LAKE CITY
DRINKING WATER SYSTEM MASTER PLAN

PROJECT LOCATIONS

FIGURE VII-1

FUNDING OPTIONS

Funding options for the recommended projects, in addition to water use fees, could include the following options: general obligation bonds, revenue bonds, State/Federal grants and loans, and impact fees. In reality, the City may need to consider a combination of these funding options. The following discussion describes each of these options.

General Obligation Bonds

This form of debt enables the City to issue general obligation bonds for capital improvements and replacement. General Obligation (G.O.) Bonds would be used for items not typically financed through the Water Revenue Bonds (for example, the purchase of water source to ensure a sufficient water supply for the City in the future). G.O. bonds are debt instruments backed by the full faith and credit of the City which would be secured by an unconditional pledge of the City to levy assessments, charges or ad valorem taxes necessary to retire the bonds. G.O. bonds are the lowest-cost form of debt financing available to local governments and can be combined with other revenue sources such as specific fees, or special assessment charges to form a dual security through the City's revenue generating authority. These bonds are supported by the City as a whole, so the amount of debt issued for the water system is limited to a fixed percentage of the real market value for taxable property within the City.

Revenue Bonds

This form of debt financing is also available to the City for utility related capital improvements. Unlike G.O. bonds, revenue bonds are not backed by the City as a whole, but constitute a lien against the water service charge revenues of a Water Utility. Revenue bonds present a greater risk to the investor than do G.O. bonds, since repayment of debt depends on an adequate revenue stream, legally defensible rate structure and sound fiscal management by the issuing jurisdiction. Due to this increased risk, revenue bonds generally require a higher interest rate than G.O. bonds, although currently interest rates are at historic lows. This type of debt also has very specific coverage requirements in the form of a reserve fund specifying an amount, usually expressed in terms of average or maximum debt service due in any future year. This debt service is required to be held as a cash reserve for annual debt service payment to the benefit of bondholders. Typically, voter approval is not required when issuing revenue bonds.

State/Federal Grants and Loans

Historically, both local and county governments have experienced significant infrastructure funding support from state and federal government agencies in the form of block grants, direct grants in aid, interagency loans, and general revenue sharing. Federal expenditure pressures and virtual elimination of federal revenue sharing dollars are clear indicators that local government may be left to its own devices regarding infrastructure finance in general. However, state/federal grants and loans should be further investigated as a possible funding source for needed water system improvements.

It is also important to assess likely trends regarding federal / state assistance in infrastructure financing. Future trends indicate that grants will be replaced by loans through a public works revolving fund. Local governments can expect to access these revolving funds or public works trust funds by demonstrating both the need for and the ability to repay the borrowed monies, with interest. As with the revenue bonds discussed earlier, the ability of infrastructure programs to wisely manage their own finances will be a key element in evaluating whether many secondary funding sources, such as federal/state loans, will be available to the City.

Impact Fees

Impact fees can be applied to water related facilities under the Utah Impact Fees Act. The Utah Impacts Fees Act is designed to provide a logical and clear framework for establishing new development assessments. It is also designed to establish the basis for the fee calculation which the City must follow in order to comply with the statute. However, the fundamental objective for the fee structure is the imposition on new development of only those costs associated with providing or expanding water infrastructure to meet the capacity needs created by that specific new development. Also, impact fees cannot be applied retroactively.

SUMMARY OF RECOMMENDATIONS

Several recommendations were made throughout the master plan report. A summary of the recommendations is presented below, with the projects organized by whether they apply to existing or future deficiencies.

Existing recommendations which should be completed within the next five years:

- Construct a replacement for Bolinder Well and return the Bolinder Tank and Pump Station to service. It is expected that the storage should be expanded by 0.5 MG and that the capacity of the booster pumps should be increased to 3,200 gpm.
- Replace the existing booster pump station at the 300 East Tank with a new pump station with a rated capacity of 1,200 gpm.
- Construct a new pump station at Davis Tank with a rated capacity of 4,640 gpm.
- All of the Zone 1 fire flow projects should be completed.
- Projects necessary for providing fire flow volume to Zone 2 should also be completed. Two separate options have been suggested above. The first option presented was to obtain the fire flow from Salt Lake City and the second option included capital improvements to allow water from 1300 East Tank to be used in Zone 2.
- The City should update the model as the water system changes.
- Continue to monitor water quality test results, particularly in the northeast area of the City. If problem areas are identified, use the water quality model to determine source production patterns which promote water circulation.
- Maximize the use of equalization storage in the tanks, especially 1300 East Tank.

Future recommendations which should be monitored and addressed as needed:

- Construct a new well in Zone 1 to address projected future source deficiencies.
- Install a new JVWCD connection to the existing 10” South Salt Lake pipeline at 3300 S West Temple.
- Construct a new 1 MG Zone 1 storage tank alongside the existing 1300 East Tank.

REFERENCES

Environmental Protection Agency (EPA). 2006. *Fluoride: Dose-Response Analysis For Non-cancer Effects*. EPA 820-R-10-019. U.S. Environmental Protection Agency, Health and Ecological Criteria Division, Office of Water. Washington, D.C.

Governor's Office of Planning & Budget, 2013.

International Fire Code Institute, Uniform Fire Code, 1997.

State of Utah, Utah Administrative Code.

APPENDIX A
ERC Calculations

Given Annual Production data

Find The total number of ERCs, and ERC breakdown for South Salt Lake City

Solution

Annual use info for 2009 gives the following totals

Connections

Domestic: 2605
Commercial: 698

(meter data indicates the total 2010 connections is 3,426)

Annual Use

Domestic: 1131.63 Acre-feet
Commercial: 1232.32 Acre-feet

Define ERC ⇒ South Salt Lake is in Zone 4 of the Consumptive use map which give 3.96 gpm/acre
(R309-510). Reviewed 10 residential properties, the average irrigated acreage/property was ~0.09 acres

$$\frac{800 \text{ gal}}{d \cdot \text{Conn}} \cdot \frac{d}{1440 \text{ min}} + \frac{3.96 \text{ gal}}{\text{min} \cdot \text{acre}} \cdot \frac{0.09 \text{ Acres}}{\text{conn}} = 0.91 \text{ gpm/ERC}$$

Convert Commercial/Industrial connections to ERCs

$$\frac{1232.32 \text{ Acre-ft}/698 \text{ Com/Ind}}{1131.63 \text{ Acre-ft}/2605 \text{ ERCs}} = 4.06 \frac{\text{ERCs}}{\text{com/Ind conn}}$$

Calculate ERCs for Open Space

South Salt Lake GIS Gives 206 acres of Public Open Space (from SSL Planning Map)

$$206 \text{ Acres} \cdot 3.96 \frac{\text{gpm}}{\text{Acre}} = 816 \text{ gpm}$$

Calculate total ERCs

$$2605 \text{ ERCs} + 4.06 \frac{\text{ERCs}}{\text{Com/Ind Conn}} (698 \text{ conn.}) + 816 \text{ gpm} / 0.91 \text{ gpm/ERC}$$

$$= 2{,}605 \text{ ERCs} + 2{,}837 \text{ ERCs} + 895 \text{ ERCs} = 6337 \text{ ERCs}$$

City of South Salt Lake Drinking Water Master Plan

System Characteristics - Existing vs Future

126.27.100

Revised 6/13/2013

SYSTEM COMPONENTS	EXISTING	FUTURE	
Population	22,274	44,560	ppl
Population Growth	22,286		ppl
% Population Growth	100.05%		Percent
# Connections	3,303	6,608	Conn.
Growth of ERCs	**6,340**		**ERC**
System ERCs	6,337	**12,677**	ERC
ERCs in Zone 1	5,542	11,882	ERC
ERCs in Zone 2	795	795	ERC
ERCs/Connections	1.92		ERC/Conn
Irr. Crop Consumptive Use Zone	4		Zone
Irr. Acres per ERC	0.09		Irr. Ac/ERC
Estimated Irr. Acres	570	570	ac

Population growth is based on estimates made in 2008 from the Governor's Office of Planning and Budget

Input

Output

PEAK DAY DEMAND	EXISTING	FUTURE	
Outdoor Peak Day State Standard	3.96		gpm/irr ac
	2,259	2,259	gpm
Indr. Peak Day SS	800		gpd/ERC
Indoor Peak Day State Standard	0.556		gpm/ERC
	3,521	7,043	gpm
Total Peak Day SS	**5,779**	**9,301**	gpm

PEAK INSTANTANEOUS DEMAND	EXISTING	FUTURE	
Peak Instant. (1.6x Peak Day)	9,246	14,882	gpm
Minimum Fire Flow @ 20 psi	1,200	1,200	gpm
Max Pressure Standard	110	110	psi
Min Pressure Standard	50	50	psi

AVERAGE YEARLY DEMAND	EXISTING	FUTURE	
Outdoor Average Yearly Demand	3.0		ac-ft/irr ac
State Standard	1,711	1,711	ac-ft
Indr. Average Yearly Demand SS	146,000		gal/ERC
Indoor Average Yearly Demand	925	1,851	MG/yr
State Standard	2,839	5,680	ac-ft/yr
Total Average Yearly Demand State	**4,550**	**7,391**	ac-ft/yr
Standard	2,821	4,582	gpm

State Standards require 1.87 ac-ft/irr ac. A conveyance efficiency of 90% and irrigation efficiency of 70% were used to calculate 3.0 ac-ft/irr ac

STORAGE	EXISTING	FUTURE	
Indoor Equalization SS	400		gal/ERC
Indoor Equalization SS	2.53	5.07	MG
Outdoor Equalization State Standard	2,848		gal/irr ac
	1.62	1.62	MG
Total Equalization SS	4.16	6.70	MG
Fire Suppression	2.5	2.5	MG
Emergency (20% of FF & EQ)	1.33	1.84	MG
Total	**7.99**	**11.04**	**MG**

FIRE FLOW	EXISTING	FUTURE	
Min Fire Flow	1,200	1,200	gpm
Granite Park Jr High Fire Flow	6,250	6,250	gpm
Fire Flow Duration	4	4	hr
Min Fire Volume	0.288	0.288	MG
Hospital Fire Volume	1.5	1.5	MG

FLOWS AND VOLUMES	Peak Day gpm	Ave Yr gpm	ac-ft
Existing Zone 1	5,054	2,467	3,979
Existing Zone 2	725	354	571
Existing Total	**5,779**	**2,821**	**4,550**
Future Zone 1	8,576	4,228	6820
Future Zone 2	725	354	571
Future Total	**9,301**	**4,582**	**7391**

Future ERCs

Assumptions:

1. Utah Population Estimates Committee projections are accurate
2. City-wide growth projections are representative of the growth expected in the study area, which includes the portion of the City north of 3300 South.
3. New connections only add additional indoor use

Calculations:

The Utah Population Estimates Committee estimates that the 2010 population of South Salt Lake is about 22,270 people. They further project that in 2050 the population will be 44,560, an increase of about 100%. The current number of connections within the study area is 3,303. The total number of ERCs is 6,337, producing a connection to ERC ratio of 1:1.918. Increasing the number of connections proportionally with population gives a projection of 6,608 connections in 2050 with an additional 3305 connections. Because the City is essentially "built-out", it is reasonable that additional connections will add to the indoor water demand but not to the outdoor water demand. Based on aerial imagery of South Salt Lake it is estimated that the average lot within the R-1 residential zone has 0.09 irrigable acres. The additional average day demand from new development is calculated to be:

$$3305\ conn. \times 1.918 \frac{ERC}{conn} = 6{,}340\ ERCs$$

If added to the existing 6,337 ERCs, the projected future total is 12,677 ERCs.

APPENDIX B
Water Rights

Source	WR Number	Flow (cfs)	Flow (gpm)	Status
300 East	57-1056	1.000	448.83	Certificated
	57-2660	1.050	471.27	Certificated
265 West	57-1057	1.000	448.83	Certificated
	57-8684	0.180	80.79	Certificated
	57-1058	0.820	368.04	Certificated
400 East Well	57-4246	0.172	77.20	No Action Required
	57-4247	0.082	36.80	No Action Required
	57-4248	0.082	36.80	No Action Required
	57-4249	0.107	48.02	No Action Required
	57-4250	0.078	35.01	No Action Required
	57-4251	0.016	7.18	No Action Required
	57-4253	0.056	25.13	No Action Required
	57-4254	0.056	25.13	No Action Required
	57-4255	0.134	60.14	No Action Required
	57-4256	0.033	14.81	No Action Required
	57-4257	0.125	56.10	No Action Required
	57-4258	0.134	60.14	No Action Required
	57-4259	0.096	43.09	No Action Required
	57-4260	0.051	22.89	No Action Required
	57-4261	0.060	26.93	No Action Required
	57-4262	0.045	20.20	No Action Required
	57-4263	0.096	43.09	No Action Required
	57-4264	0.082	36.80	No Action Required
	57-4265	0.071	31.87	No Action Required
700 East	57-8374	1.560	700.18	Certificated
	57-8789	2.440	1,095.15	Proof due 10/31/2014
Bolinder Well	57-3157	1.000	448.83	Certificated
	57-8037	1.390	623.88	Certificated
	57-8683	2.610	1,171.45	Proof due 10/31/2020
Davis Well	57-641	2.610	1,171.45	Certificated
	57-8288	0.330	148.11	Certificated
	57-8717	1.330	596.95	Certificated
	57-6010	2.000	897.66	Certificated
	57-7515	0.290	130.16	Certificated
Scott Hatchery Wells	57-208	4.373[1]	1,962.74	Certificated
	57-5665	0.245	109.96	No Action Required
Miscellaneous	57-818	0.015	6.73	No Action Required
	57-3113	0.030	13.46	Certificated
	57-7160	0.022	9.87	No Action Required
	57-10113	NA[2]	NA	No Action Required
	Totals =	25.871	11,611.71	

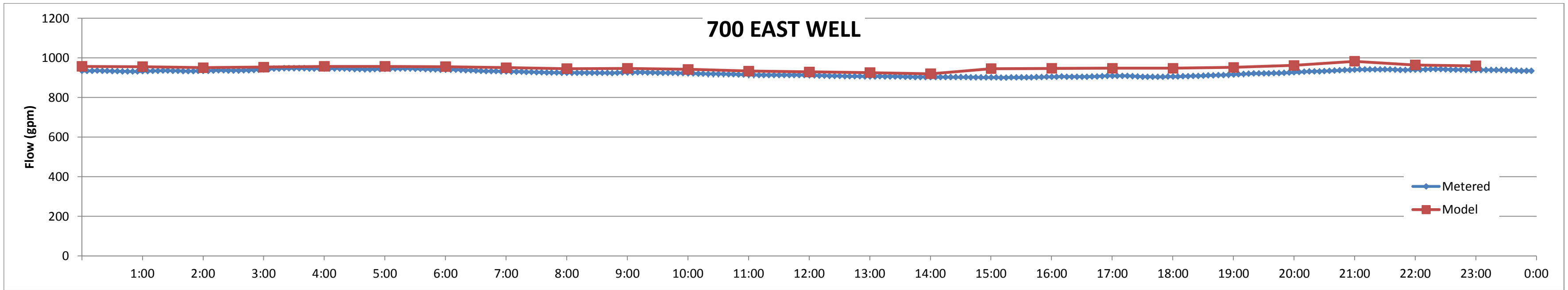
1. 57-208 is limited to an annual volume of 3006.95 acre-feet
2. 57-10113 does not have a flow rate limitation, but is limited to an annual volume of 1.1 acre-feet

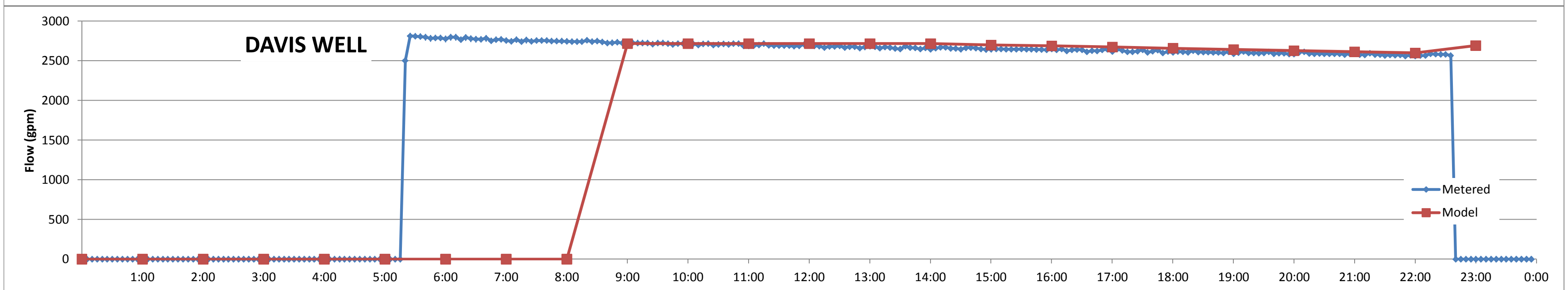
APPENDIX C
Calibration Data

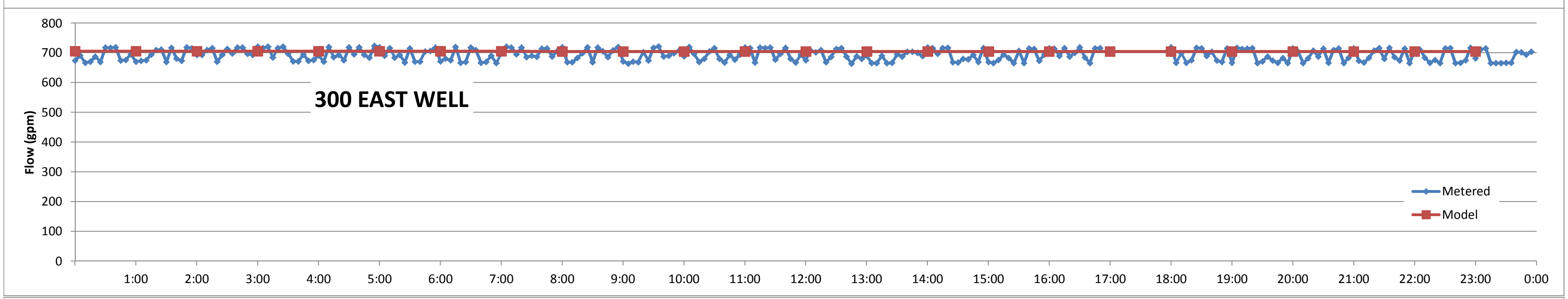
Insurance Services Office, Inc.
Hydrant Flow Data Summary
27-May-03

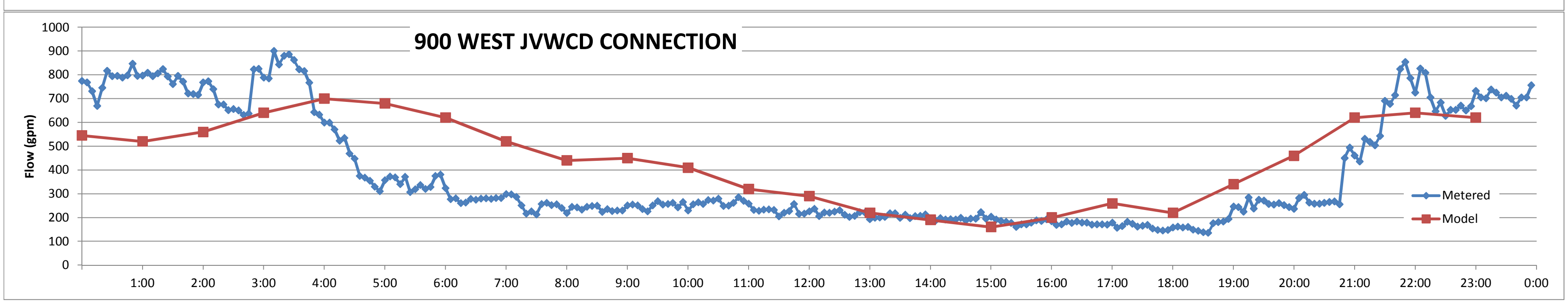
Test No.	Type Dist.	Test Location	Service	Flow (gpm) $Q=(29.83(C(d^2)p^{0.5}))$ Individual Hydrants		Total	Pressure (psi) Static	Resid.	Flow (gpm) @ 20 psi $Q_R=Q_F(h_R^{0.54}/h_F^{0.54})$ Needed	Avail.	Remarks	Model Node	Pressure (psi) Static	Diff.	(psi) Resid.	Diff.	Zone
1	Commercial	2565 S 300 W	SSLC	1,210	1,030	2,240	96	84	9,000	6,100	(A)-(4760 gpm)	J-152	80	-17%	66	-21%	1
1A	Commercial	2566 S 300 W	SSLC	1,210	1,030	2,240	96	84	3,500	6,100		J-152	80	-17%	66	-21%	1
2	Commercial	909 W 2900 S	SSLC	1,260		1,260	90	45	5,000	1,600		J-50	98.88	10%			2
2A	Commercial	910 W 2900 S	SSLC	1,260		1,260	90	45	3,500	1,600		J-50	98.88	10%			2
3	Commercial	3180 S Eldridge	SSLC	1,110	1,570	2,680	95	65	6,500	4,400	(A)-(3090 gpm)	J-199	78	-18%	43	-34%	1
3A	Commercial	3181 S Eldridge	SSLC	1,110	1,570	2,680	95	65	2,000	4,400		J-199	78	-18%	43	-34%	1
4	Commercial	2330 S 300 W	SSLC	1,060	2,120	3,180	96	75	4,500	6,400		J-109	81.5	-15%	73	-3%	1
4A	Commercial	2331 S 300 W	SSLC	1,060	2,120	3,180	96	75	3,500	6,400		J-109	81.5	-15%	73	-3%	1
5	Commercial	Burton 200 W	SSLC	1,220		1,220	96	85	4,500	3,500	(A)-(3090 gpm)	J-130	81	-16%	68	-20%	1
5A	Commercial	Burton 200 W	SSLC	1,220		1,220	96	85	2,500	3,500		J-130	81	-16%	68	-20%	1
6	Commercial	2700 S 600 W	SSLC	760	1,620	2,380	100	65	4,000	3,700	(A)-(2840 gpm)	J-62	82.5	-18%	66	2%	1
7	Commercial	3007 S West Temple	SSLC	1,030	1,810	2,840	89	70	4,000	5,700		J-224	75.5	-15%	65	-7%	1
7A	Commercial	3008 S West Temple	SSLC	1,030	1,810	2,840	89	70	2,500	5,700		J-224	75.5	-15%	65	-7%	1
8	Commercial	3131 S West Temple	SSLC	580	530	1,110	85	75	4,000	3,100		J-215	75	-12%	73	-3%	1
8A	Commercial	3132 S West Temple	SSLC	580	530	1,110	85	75	3,500	3,100		J-215	75	-12%	73	-3%	1
9	Commercial	3148 S 1100 W	SSLC	480	860	1,340	90	40	4,000	1,600		12	98.35	9%			2
10	Commercial	Oakland Ave State St	SSLC	1,580	1,680	3,260	80	65	4,000	3,900		J-311	73.5	-8%	72	11%	1
10A	Commercial	Oakland Ave State St	SSLC	1,580	1,680	3,260	80	65	1,250	3,900		J-311	73.5	-8%	72	11%	1
11	Commercial	2600 S 900 W	SSLC	1,160	1,300	2,460	125	95	3,500	4,800	(C)-(2827 gpm)	J-405	100.25	-20%			2
12	Commercial	420 E 3760 S	SSLC	1,030		1,030	66	58	3,000	2,600		NA					
12R	Residential	421 E 3760 S	SSLC	1,030		1,030	66	58	1,500	2,600		NA					
13	Commercial	3410 S 700 W	SSLC	760		760	90	66	2,500	1,400		NA					
14	Commercial	3645 S State St	SSLC	1,170		1,170	80	65	2,000	2,500		NA					

Zone	average	stdev
1	-15%	3%
2	2%	15%


700 EAST WELL
Flow (gpm)
Metered
Model


DAVIS WELL
Flow (gpm)
Metered
Model


300 EAST WELL
Flow (gpm)
Metered
Model


900 WEST JVWCD CONNECTION
Flow (gpm)
Metered
Model

APPENDIX D
Computer Model Output

SEE DISK

APPENDIX E
Water quality Calibration Data

Water Quality Calibration Results

	Test	Model	Diff.
Junction	mg/L	mg/L	
J-111	0.14	0.16	16%
J-8	0.16	0.19	23%
J-405	0.18	0.06	-67%
J-50	0.15	0.18	17%
J-276	0.09	0.04	-57%
J-306	0.11	0.05	-52%
J-243	0.12	0.14	15%
J-63	0.14	0.17	19%
J-152	0.11	0.15	39%
J-210	0.13	0.08	-42%
J-82	0.10	0.04	-58%
J-122	0.12	0.10	-10%
J-226	0.14	0.14	1%
J-194	0.13	0.16	25%
J-239	0.13	0.08	-37%
J-461	0.14	0.17	19%
J-471	0.11	0.16	42%
J-458	0.13	0.18	38%
J-387	0.10	0.19	90%

APPENDIX F
Cost Estimate Calculations

COST CALCULATIONS FOR RECOMMENDED PROJECTS

MAP ID	Project Description	UNIT	UNIT TYPE	UNIT COST	COST	Contingency (20%) and Engineering (15%)	TOTAL COST
1	Replacment fo Bolinder Well	1	ea	$700,000.00	$700,000	$245,000	$945,000
NA	New Zone 1 Well	1	ea	$700,000.00	$700,000	$245,000	$945,000
2	JVWCD Connection at 3300 S West Temple	1	ea	$30,000.00	$30,000	$10,500	$41,000
3	New 300 East booster station	1	ea	$400,000.00	$400,000	$140,000	$540,000
4	New Davis Tank booster station	1	ea	$800,000.00	$800,000	$280,000	$1,080,000
5	Build new 0.5 MG Tank	500,000	gal	$0.80	$400,000	$140,000	$540,000
6	New Bolinder booster station	1	ea	$625,000.00	$625,000	$218,750	$844,000
7	Build new 1.0 MG Tank	1,000,000	gal	$0.80	$800,000	$280,000	$1,080,000
8	Install fire hydrant	1	ea	$5,000.00	$5,000	$1,750	$7,000
9	725 feet of 8-inch pipe	725	foot	$92.00	$66,700	$23,345	$90,000
10	725 feet of 8-inch pipe	725	foot	$92.00	$66,700	$23,345	$90,000
11	450 feet of 10-inch pipe	450	foot	$103.00	$46,350	$16,223	$63,000
12	1,550 feet of 10-inch pipe	1,550	foot	$103.00	$159,650	$55,878	$216,000
13	785 feet of 8-inch pipe	785	foot	$92.00	$72,220	$25,277	$97,000
14	410 feet of 8-inch pipe	410	foot	$92.00	$37,720	$13,202	$51,000
15	1,465 feet of 12" pipeline	1,465	foot	$116.00	$169,940	$59,479	$229,000
16	1,900 feet of 16" pipe	1,900	foot	$130.00	$247,000	$86,450	$333,000
17	6,500 feet of 16" pipe	6,500	foot	$130.00	$845,000	$295,750	$1,141,000
	Millcreek crossing	60	foot	$260.00	$15,600	$5,460	$21,000
	Railroad crossing	1	ea	$150,000.00	$150,000	$52,500	$203,000
18	2,480 feet of 18" pipline	2,390	feet	$152.00	$363,280	$127,148	$490,000
	Concrete street crossing	90	foot	$290.00	$26,100	$9,135	$35,000
19	Connection across State Street	1	ea	$50,000.00	$50,000	$17,500	$68,000
20	1,740 feet of 10" pipeline	1,740	foot	$103.00	$179,220	$62,727	$242,000

TOTAL $9,391,000

APPENDIX G
DDW Report Certification

HYDRAULIC MODEL DESIGN ELEMENTS & SYSTEM CAPACITY EXPANSION REPORT

REPORT CERTIFICATION

It is herby certified that the Hydraulic Model Design Elements & System Capacity Expansion Report for:

City of South Salt Lake Drinking Water Master Plan
(Project Name)

18032
(Water System Number)

South Salt Lake Culinary Water
(Water System Name)

____
(DDW File Number, If Available)

7/15/2013
(Date)

Meets all requirements as set forth in *R309-511 Hydraulic Modeling Rule* and *R309-110-4 Definitions* and complies with the provisions thereof, as well as the sizing requirements of *R309-510*, and the minimum water pressures of *R309-105-9*. Where applicable the proposed additions to the distribution system will not cause the pressures at any new or existing connections to be less than those specified in R309-105-9. The calibration methodology is described in the report and the model is sufficiently calibrated and accurate to represent the conditions within this water system. The hydraulic modeling method is (*use of computer software or hand calculations*), and the computer software used was *(name and version).*

Steven C. Jones, P.E.

State of Utah No. 362076-2202

CHECKLIST FOR HYDRAULIC MODEL DESIGN ELEMENTS REPORT

This hydraulic model checklist identifies the components included in the Hydraulic Model Design Elements Report for

City of South Salt Lake Drinking Water Master Plan
(Project Name)

18032
(Water System Number)

South Salt Lake Culinary Water
(Water System Name)

7/15/2013
(Date)

The checkmarks or P.E. initials after each item indicate the conditions supporting P.E. Certification of this Report.

1. The Report contains:

(a) A listing of sources including: the source name, the source type (i.e., well, spring, reservoir, stream etc.) for both existing sources and additional sources identified as needed for system expansion, the minimum reliable flow of the source in gallons per minute, the status of the water right and the flow capacity of the water right. *[R309-110-4 "Master Plan" definition]* ☑ SA

(b) A listing of storage facilities including: the storage tank name, the type of material (i.e., steel, concrete etc.), the diameter, the total volume in gallons, and the elevation of the overflow, the lowest level (elevation) of the equalization volume, the fire suppression volume, and the emergency volume or the outlet. *[R309-110-4 "Master Plan" definition]* ☑ SA

(c) A listing of pump stations including: the pump station name and the pumping capacity in gallons per minute. Under this requirement one does not need to list well pump stations as they are provided in requirement (a) above. *[R309-110-4 "Master Plan" definition]* ☑ SA

(d) A listing by customer type (i.e., single family residence, 40 unit condominium complex, elementary school, junior high school, high school, hospital, post office, industry, commercial etc.) along with an assessment of their associated number of ERC'S. *[R309-110-4 "Master Plan" definition]* ☑ SA

(e) The number of connections along with their associated ERC value that the public drinking water system is committed to serve, but has not yet physically connected to the infrastructure. *[R309-110-4 "Master Plan" definition]* ☑ SA

(f) A description of the nature and extent of the area currently served by the water system and a plan of action to control addition of new service connections or expansion of the public drinking water system to serve new development(s). The plan shall include current number of service connections and water usage as well as land use projections and forecasts of future water usage. *[R309-110-4 "Master Plan" definition]* ☑ SA

(h) A hydraulic analysis of the <u>existing</u> distribution system along with any proposed distribution system expansion identified in (g) above. *[R309-110-4 "Master Plan" definition]* ☑ SA

(i) A description of potential alternatives to manage system growth, including interconnections with other existing public drinking water systems, developer responsibilities and requirements, water rights issues, source and storage capacity issues and distribution issues. *[R309-110-4 "Master Plan" definition]* ☑ SA

2. At least 80 percent of the total pipe lengths in the distribution system affected by the proposed project are included in the model. *[R309-511-5(1)]* ☑ SA

3. 100 percent of the flow in the distribution system affected by the proposed project is included in the model. If customer usage in the system is metered, water demand allocations in the model account for at least 80 percent of the flow delivered by the distribution system affected by the proposed project. *[R309-511-5(2)]* ☑ SA

4. All 8-inch diameter and larger pipes are included in the model. Pipes smaller than 8-inch diameter are also included if they connect pressure zones, storage facilities, major demand areas, pumps, and control valves, or if they are known or expected to be significant conveyers of water such as fire suppression demand. *[R309-511-5(3)]* ☑ SA

5. All pipes serving areas at higher elevations, dead ends, remote areas of a distribution system, and areas with known under-sized pipelines are included in the model. *[R309-511-5(4)]* ☑ SA

6. All storage facilities and accompanying controls or settings applied to govern the open/closed status of the facility for standard operations are included in the model. *[R309-511-5(5)]* ☑ SA

7. Any applicable pump stations, drivers (constant or variable speed), and accompanying controls and settings applied to govern their on/off/speed status for various operating conditions and drivers are included in the model. *[R309-511-5(6)]* ☑ SA

8. Any control valves or other system features that could significantly affect the flow of water through the distribution system (i.e. interconnections with other systems,

pressure reducing valves between pressure zones) for various operating conditions are included in the model. *[R309-511-5(7)]* ☑

9. Imposed peak day and peak instantaneous demands to the water system's facilities are included in the model. The Hydraulic Model Design Elements Report explains which of the Rule-recognized standards for peak day and peak instantaneous demands are implemented in the model (i.e., (i) peak day and peak instantaneous demand values per *R309-510, Minimum Sizing Requirements*, (ii) reduced peak day and peak instantaneous demand values approved by the Executive Secretary per *R309-510-5, Reduction of Requirements*, or (iii) peak day and peak instantaneous demand values expected by the water system in excess of the values in *R309-510, Minimum Sizing Requirements*). The Hydraulic Model Design Elements Report explains the multiple model simulations to account for the varying water demand conditions, or it clearly explains why such simulations are not included in the model. The Hydraulic Model Design Elements Report explains the extended period simulations in the model needed to evaluate changes in operating conditions over time, or it clearly explains (e.g., in the context of the water system, the extent of anticipated fire event, or the nature of the new expansion) why such simulations are not included in the model. *[R309-511-5(8) & R309-511-6(1)(b)]* ☑

10. The hydraulic model incorporates the appropriate demand requirements as specified in *R309-510, Minimum Sizing Requirements*, and *R309-511, Hydraulic Modeling Rule*, in the evaluation of various operating conditions of the public drinking water system. The Report includes:
    - the methodology used for calculating demand and allocating it to the model;
    - a summary of pipe length by diameter;
    - a hydraulic schematic of the distribution piping showing pressure zones, general pipe connectivity between facilities and pressure zones, storage, elevation, and sources; and
    - a list or ranges of values of friction coefficient used in the hydraulic model according to pipe material and condition in the system. In accordance with Rule stipulation, all coefficients of friction used in the hydraulic analysis are consistent with standard practices.

    [R309-511-7(4)] ☑

11. The Hydraulic Model Design Elements Report documents the calibration methodology used for the hydraulic model and quantitative summary of the calibration results (i.e., comparison tables or graphs). The hydraulic model is sufficiently accurate to represent conditions likely to be experienced in the water delivery system. The model is calibrated to adequately represent the actual field conditions using field measurements and observations. *[R309-511-4(2)(b), R309-511-5(9), R309-511-6(1)(e) & R309-511-7(7)]* ☑

12. The Hydraulic Model Design Elements Report includes a statement regarding whether fire hydrants exists within the system. Where fire hydrants are connected to the distribution system, the model incorporates required fire suppression flow standards. The statement that appears in the Report also

identifies the local fire authority's name, address, and contact information, as well as the standards for fire flow and duration explicitly adopted from *R309-510-9(4), Fireflows*, or alternatively established by the local fire suppression agency, pursuant to *R309-510-9(4), Fireflows.* The Hydraulic Model Design Elements Report explains if a steady-state model was deemed sufficient for residential fire suppression demand, or acknowledges that significant fire suppression demand warrants extended model simulations and explains the run time used in the simulations for the period of the anticipated fire event. *[R309-511-5(10) & R309-511-7(5)]*

☑ SA

13. If the public drinking water system provides water for outdoor use, the Report describes the criteria used to estimate this demand. If the irrigation demand map in *R309-510-7(3), Estimated Outdoor Use,* is not used, the report provides justification for the alternative demands used in the model. If the irrigation demands are based on the map in *R309-510-7(3), Estimated Outdoor Use,* the Report identifies the irrigation zone number, a statement and/or map of how the irrigated acreage is spatially distributed, and the total estimated irrigated acreage. The indicated irrigation demands are used in the model simulations in accordance with Rule stipulation. The model accounts for outdoor water use, such as irrigation, if the drinking water system supplies water for outdoor use. *[R309-511-5(11) & R309-511-7(1)]*

☑ SA

14. The Report states the total number of connections served by the water system including existing connections and anticipated new connections served by the water system after completion of the construction of the project. *[R309-511-7(2)]*

☑ SA

15. The Report states the total number of equivalent residential connections (ERC) including both existing connections as well as anticipated new connections associated with the project. In accordance with Rule stipulation, the number of ERC's includes high as well as low volume water users. In accordance with Rule stipulation, the determination of the equivalent residential connections is based on flow requirements using the anticipated demand as outlined in *R309-510, Minimum Sizing Requirements*, or is based on alternative sources of information that are deemed acceptable by the Executive Secretary. *[R309-511-7(3)]*

☑ SA

16. The Report identifies the locations of the lowest pressures within the distribution system, and areas identified by the hydraulic model as not meeting each scenario of the minimum pressure requirements in *R309-105-9, Minimum Pressure Requirements. [R309-511-7(6)]*

☑ SA

17. The Hydraulic Model Design Elements Report identifies the hydraulic modeling method, and if computer software was used, the Report identifies the software name and version used. *[R309-511-6(1)(f)]*

☑ SA

18. For community water system models, the community water system management has been provided with a copy of input and output data for the hydraulic model

with the simulation that shows the worst case results in terms of water system pressure and flow. *[R309-511-6(2)(c)]* ☑ 84

19. The hydraulic model predicts that new construction will not result in any service connection within the new expansion area not meeting the minimum distribution system pressures as specified in *R309-105-9, Minimum Pressure Requirements.* *[R309-511-6(1)(c)]* ☑ 84

20. The hydraulic model predicts that new construction will not decrease the pressures within the existing water system to such that the minimum pressures as specified in *R309-105-9, Minimum Pressure Requirements* are not met. *[R309-511-6(1)(d)]* ☑ 84